ISSN 0377-9335

entomon

A Quarterly Journal of Entomological Research

Vol. 12 DECEMBER 1987 No. 4

PUBLISHED BY
THE ASSOCIATION FOR ADVANCEMENT OF ENTOMOLOGY
DEPARTMENT OF ZOOLOGY, UNIVERSITY OF KERALA, KARIAVATTOM
TRIVANDRUM, INDIA 695 581

ENTOMON

Entomon is a quarterly journal of the Association for Advancement of Entomology issued in March, June, September and December, devoted to publication of research work on various aspects of insects and other land arthropods.

Address MS and all editorial correspondence to Managing Editor, *Entomon*, Department of Zoology, University of Kerala, Kariavattom, Trivandrum, India 695 581.

SUBSCRIPTION RATES

Annual Subscription for institutions: Rs 150/- (in India); $ 50/- (abroad, air mail)
,, ,, individuals: Rs 50/- ,, ; $ 20/- (,, sea mail)

1. **All remittance to the journal or the Association should be sent to the Secretary-Treasurer of the Association by bank draft only, A/c payee in favour of the Association for Advancement of Entomology.**

2. **Requests for replacement copies of ENTOMON in lieu of numbers lost in transit, should reach the Secretary-Treasurer not later than three months after the date of publication of the number.**

entomon

Vol. 12 December 1987 Number 4

CONTENTS

REPORTS AND NEW RECORDS

Entomon, 1987, *Vol.* 12, *No.* 4, *pp.* 295 *to* 300

DISTRIBUTION PATTERN OF IMMATURE STAGES OF EPILACHNA BEETLE *HENOSEPILACHNA VIGINTIOCTO-PUNCTATA* FABR ON BRINJAL

C. L. SUMAN[1], CLEMENT PETER[2] SUDHA NAGARKATTI[3] & S. D. WAHI[4]

Indian Institute of Horticultural Research, Bangalore, India 560 080

(Received 6 February 1986)

Spatial distribution of egg clusters and immature stages of the epilachna beetle, *Henosepilachna vigintioctopunctata* Fabr was studied for six generations. Mean crowding and Lloyd index of patchiness indicated that egg cluster counts approximated random dispersion with a tendency toward aggregation at higher densities. The larval and pupal populations followed aggregation dispersion. For all the six generations, the larval population was suitably explained by negative binomial distribution because of agreement between observed and expected frequencies.

INTRODUCTION

Among the insects that attack brinjal, potato and other solanaceous plants, the epilachna beetle, *Henosepilachna vigintioctopunctata* (F) is very important in India. It is one of the most widely distributed and persistent pests of solanaceous plants. Both the adults and larvae feed on and skeletonize the leaves and are a serious limiting factor in cultivation of potato and brinjal (KRISHNAMURTHY, 1932).

Distribution patterns of insects provide useful information in formulating management strategies for their control. The distribution behaviour also affect the sampling programme, method of analysing data and investigations on the dynamics of pest populations when changes in size are considered. An adequate knowledge of distribution further justifies the statistical analysis for suitable transformation of data to stabilize variance which is a basic requirement of analysis of variance. Sequential sampling plans of pest populations can only be developed if the distribution pattern of the pest is well known.

The present study was conducted over six generations of the epilachna beetle to determine its distribution pattern in all the immature stages (i e., from egg to pupal stage) under natural condition.

MATERIALS AND METHODS

The study was conducted at the Experimental Research Station, Hessaraghatta, of the Indian Institute of Horticultural Research, Banglore from February 1979 to December 1980. The widely cultivated variety of brinjal, 'Pusa purple long' was used as the host plant. The plants were spaced allowing 60 cm between rows and 50 cm between plants. All

Present address :

[1] Indian Veterinary Research Institute, Izatnagar, U P, 243122.

[2] Frederick Institute of Plant Protection and Toxicology, Padappai 601301, Chingleput (Distt.)

[3] North Carolina Department of Agriculture, 11130 Blue Heron Drive, Pineville, N C 28134 U S A.

[4] I A S R I., Library Avenue, New Delhi 110012.

recommended agricultural practics were adopted except plant protection measures in order to allow the pest population to multiply under natural conditions. The individual plant was taken as a sampling unit for recording data on pest counts (*i e.*, number of egg clusters, first instar to pupal stage). Continuity of pest generations was maintained by raising the crop regularly. Data was recorded twice weekly throughout study period.

Experimental details of the generations regarding time of planting, number of plants sampled and period of observations are shown in Table 1.

For each generation, data pertaining to total number of egg clusters, first to fourth instars and pupal population was obtained and summarised in the form of frequency tables. The nature of dispersion was studied by determining k-value; mean crowding and index of patchiness (LLOYD, 1967). Many workers (ANSCOMBE, 1949 ; WADLEY, 1950; EVANS, 1953; BLISS & OWEN, 1958; SUMAN *et al.*, 1980a, b, 1981) have shown that the population following aggregation dispersion can be adequately expressed by the negative binomial distibution which is explained by two parameters, mean 'M' and exponent 'K' which is calculated by the formula:

$$K = \frac{\bar{x}}{S^2 - \bar{x}}$$

where $\bar{x}$ and S^2 are sample estimates of population mean and variance.

RESULTS AND DISCUSSION

Statistical parameters describing the nature of dispersion of egg cluster counts and larval population of epilachna beetle for all the six generations have been presented in Table 2. The variance of egg cluster counts was found to be less than the mean for the first, second and sixth generations, while other generations showed a slightly higher values. This is indicative of random dispersion of egg laying pattern of adult population. With the increase in number of egg clusters per plant there appears to be some degree of aggregation of egg clusters as seen from data for the third, fourth and fifth generations. All the larval stages of epilachna beetle showed significantly higher values of variance than the mean for all the generations which revealed a high degree of aggregation of the larval population. The main cause of aggregation appears to be a result of the oviposition behaviour of females since eggs are laid in clusters as explained by TAYLOR (1961). All values of variance decreased with the growth of population indicating homogeneity of the data.

The value of the dispersion parameter 'K' for egg cluster counts was either high or negative in all the generations supporting random dispersion of egg cluster counts. For all the larval stages of the pest, the highest value of 'K' was observed in the

TABLE 1. Experimental details of brinjal crop and observation periods.

Generation	time of transplanting	no. of plants observed	period of observation
I	February 1979	81	March 15, 1979 to April 15, 1979
II	April 1979	153	May 21, 1979 to June 30, 1979
III	June 1979	210	July 20, 1979 to August 30, 1979
IV	January 1980	203	Feb. 17, 1980 to March 31, 1980
V	March 1980	210	April 21, 1980 to May 30, 1980
VI	July 1980	120	August 15, 1980 to Sept. 21, 1980

TABLE 2. Statistical parameters of dispersion behaviour of epilachna beetle *Henosepilachna vigintioctopunctata.*

Generation no.	reference stage of pest	mean $\bar{x}$	variance (S^2)	dispersion parameter (K)	mean crowding X*	Lloyd index	chi-square value	degrees of freedom	probability of fit between
1	2	3	4	5	6	7	8	9	10
I	Egg clusters	1.0854	0.2765	—	0.3401	0.3134	—	—	—
	First instar	17.5556	477.7249	0.6697	43.7677	2.4931	4.5051	6	0.50 — 0.70
	Second instar	4.6543	77.7249	0.2964	20.3548	4.3733	3.0102	5	0.50 — 0.70
	Third instar	2.1235	37.9596	0.2123	18 9994	8.9472	3.1114	5	0.50 — 0.70
	Fourth instar	1.0864	8.1549	0.1670	7.5928	6.9839	2.9197	4	0.50 — 0.70
	Pupae	0.5802	2.0716	0.2258	3.1507	5.4304	1.8108	4	0.70 — 0.80
II	Egg clusters	1.5817	1.5817	1.8633	8.8826	1.7597	1.1126	—	—
	First instar	19.0850	430.1440	0 8867	40.6233	2.1285	6.9187	7	0.30 — 0.50
	Second instar	7.8627	99.4881	0.6750	19.5108	2.4814	2.1919	6	0.80 — 0.90
	Third instar	3.6645	33.6549	0.4478	11.8485	3.2333	4.5918	6	0.50 — 0.70
	Fourth instar	2.6645	25.9330	0.3051	11.3973	4.2775	3.1817	5	0.50 — 0.70
	Pupae	0.7434	5.1324	0.1259	6.6474	8.9418	2.1118	4	0.70 — 0.80
III	Egg clusters	1.4251	0.9640	—	1.1015	0.7729	—	—	—
	First instar	36.4010	542.9113	2.6160	50.3157	1.3823	7.1121	7	0.30 — 0.50
	Second instar	26.7633	416.3272	1.8386	41.3192	1.5439	6.0012	7	0.50 — 0.70
	Third instar	19.8116	166.8236	2.6698	27.2321	1.3745	2.1109	6	0.80 — 0.90
	Fourth instar	15.3237	115.2588	2.3497	21.8453	1.4256	3.4108	5	0.50 — 0.70
	Pupae	9.8647	74.3408	1.5093	16.4007	1.6626	2 0001	4	0.70 — 0.80

(Contd. on next page)

TABLE 2. Contd.

1	2	3	4	5	6	7	8	9	10
IV	Egg clusters	2.5566	5.0698	2.6009	3.5396	1.3845	—	—	—
	First instar	20.3202	432.9712	1.0006	40.9216	2.0134	3.9107	6	0.50 — 0.70
	Second instar	13.5271	243.5772	0.7954	30.5337	2.2572	4.0109	6	0.50 — 0.70
	Third instar	10.5212	160.4321	0.7384	18.2312	2.0191	3.9701	6	0.50 — 0.70
	Fourth instar	8.3892	86.5062	0.9009	17.7008	2.1099	2.3190	4	0.80 — 0.90
	Pupae	3.8818	35.9265	0.4702	12.1369	3.1266	1.9810	4	0.80 — 0.90
V	Egg clusters	1.5048	1.7907	7.9191	1.6948	1.1262	—	—	—
	First instar	25.4714	658.1559	1.0255	50.3104	1.9752	7.0110	6	0.30 — 0.50
	Second instar	22.1524	391.3874	1.3290	38.8202	1.7524	5.1171	7	0.50 — 0.70
	Third instar	19.1095	289.3612	1.3512	33.2518	1.7901	5.1991	6	0.50 — 0.70
	Fourth instar	16.3048	228.5765	1.2524	29.3237	1.7985	4.3210	6	0.30 — 0.50
	Pupae	11.1571	220.5828	0.5944	29.9277	2.6821	3.2109	4	0.50 — 0.70
VI	Egg clusters	0.1667	0.9636	—	0.9926	0.8608	—	—	—
	First instar	16.2000	271.4218	1.0283	31.9544	1.9725	4.3109	6	0.50 — 0.70
	Second instar	8.9333	98.4829	0.8912	18.9575	2.1221	4.0106	5	0.50 — 0.70
	Third instar	4.0833	24.4132	0.8203	9.0621	2.2193	5.0108	5	0.30 — 0.50
	Fourth instar	1.5833	5.6401	0.6187	4.1455	2.6183	3.0991	4	0.30 — 0.50
	Pupae	0.7083	1.5293	0.6187	1.8533	2.6165	2.9090	4	0.30 — 0.50

third generation followed by the fifth and fourth generations respectively. In all the generations the value of the dispersion parameter decreased with the growth of the population except in the third generation in which, third instar larvae showed a higher value than the first and second instar larvae. Also in the third generation the value of dispersion parameter decreased after the third instar. These values revealed that though the population density varied in each generations, the larval population showed a high degree of aggregation.

Mean crowding values for egg cluster counts were either less than unity or differed non-significanltly from unity in all the generations. These values indicated that at lower population densities, the egg cluster counts followed random dispersion with a slight tendency toward aggregation with egg cluster density increased. This index showed significantly higher value than unity for all the larval stages and pupal population in all the six generations. In ecological terms, these values indicated that aggregation was an important characteristic associated with the larval population at different population densities.

The Lloyd index of patchiness, which is the ratio of mean crowding and mean density is an appropriate index of aggregation in relation to the mean. This index also showed values that were either less than unity or non-significantly different from unity for egg cluster counts in all the generations which further confirmed random dispersion. In case of larval population and pupae, this index was significantly higher than unity in all the generation confirming that the epilachna beetle population follows a contagious distribution. The stability of this index at different population densities in all the generations indicated that the population tends to remain together.

Based on the findings of this study, mathematical ditributions were fitted to egg cluster counts and larval population for all the six generations separately. In case of egg cluster counts the data deviated from a negative binomial distribution while showing some closeness toward Poisson distribution. However, the probability of fit was very low and was therefore not represented in table. For the first instar, second instar, third instar, fourth instar larvae and pupae, the data showed good agreement between the observed and expected frequencies of the negative binomial distribution as seen from Chi-square values as a test of goodness of fit.

It is concluded that egg laying pattern of *H. vigintioctopunctata* approched random dispersion while immature stages (larvae and pupae) follow aggregation dispersion and the data is adequately explained by negative binomial distribution.

Acknowledgement : We are grateful to Director, IIHR for providing necessary facilities.

REFERENCES

ANSCOMBE, F. J. (1949) Statistical analysis of insect counts based on negative binomial distribution. *Biometrics*, **5**, 165—173.

BLISS, C. I. & A R. G. OWEN (1958) Negative binomial distribution with common K. *Biometrika*, **45**, 37—59.

EVANS, D. A. (1953) Experimental evidence concerning contagious distribution in ecology. *Biometrika*, **40**, 186—211.

KRISHNAMURTHY, B. (1932) The potato epilachna beetle, *Epilachna vigintioctopunctata* (Fabr). *Bull. Dept. agric. Mysore*, **9**, 1—16.

LLOYD, M. (1967) Mean crowding. *J. Anim. Ecol.*, **36**, 1—30.

SUMAN, C. L., S. D. WAHI & N. J. MOHAN (1980a) Distribution pattern on onion thrips. *Thrips tabaci* (Lind). *Curr. Sci.*, **49**, 28-29.

SUMAN, C. L., S. D. WAHI & V. G. PRASAD (1980b) Distribution behaviour of cabbage leaf webber *(Crocidolomia binotalis* Zel). under natural conditions. *Indian J. agric. Sci.*, **50**(10), 785—787.

SUMAN, C. L. & S. D. WAHI (1981) Distribution pattern of blister beetle *(Mylabris pustulata* Thumb) under natural conditions. *Entomon*, **6** (3), 271—274.

TAYLOR, L. R. (1961) Aggregation. variance and mean. *Nature*, **189**, 732—735.

WADLEY, F. M. (1950) Note on form of distribution on insect and plant populations. *Ann. ent. Soc. Amer.*, **43**, 581—586.

Entomon, 1987, *Vol.* **12**, *No.* 4, *pp.* 301 *to* 303

NEW RECORDS OF SOME TYPHLOCYBINES (HOMOPTERA : CICADELLIDAE : TYPHLOCYBINAE) AND ADDITIONAL HOST / HARBOURING PLANTS OF SOME KNOWN SPECIES FROM INDIA

A. S. Sohi, M. Shenhmar & J. S. Mann

Department of Entomology, Punjab Agricultural University, Ludhiana, India 141 004

(Received 28 April 1986)

Surveys carried out during 1985—1986 in different parts of Northwestern india, for the collection of leafhoppers, revealed the presence of nine species of typhlocybines, for the first time. Additional host harbouring plants for another seven species were also recorded. References regarding various synonyms and distributional records are already given in Sohi and Dworakowska (1984).

NEW RECORDS

Tribe Erythroneurini Young

1. Helionidia nigra Ahmed & Khokhar

Helionidia nigra Ahmed&Khokhar, 1971:69.

Material Examined : 2 males: Jammu & Kashmir : Srinagar : Pahalgaum, Batkote; ex *Rumex nepalense*, 21.vi.1985, Coll. J. S. Mann.

2. Jalalia colorata Ahmed

Jalalia colorata Ahmed, 1970 : 177.

Material Examined : 1 male 4 females, Himachal Pradesh : Solan, Kasauli; ex *Ficus carica*, 28.v.1986; 13 males 26 females, UNA : Bharwain, Chintpurni; ex *Grewia oppositifolia*, 8.ix.1986, Coll. J. S. Mann.

3. Mandola lobata (Ahmed)

Zygina lobata Ahmed, 1970 : 173

Mandola lobata (Ahmed) Dworakowska & Viraktamath, 1975 : 525.

Material Examined : 2 males, Jammu & Kashmir : Srinagar, University Campus Hazratbal; ex *Juglans regia*, 26.vi.1985, coll. J. S. Mann.

4. Qadria cajanae (Ahmed)

Erythroneura cajanae Ahmed, 1971a : 185.

Qadria cajanae (Ahmed Dworakowska, 1979 : 157.

Material Examined : 1 male, Punjab : Ludhiana, Raikot; ex *Hordeum vulgare*, 8.iv.1985, coll. J. S. Mann.

5. Tautoneura redama Dworakowska

Tautoneura redama Dworakowska 1981 b: 197.

Material Examined : 1 male, Himachal Pradesh : Solan, Kasauli; ex *Ficus carica*, 28.v.1986, coll. J. S. Mann.

6. Gambialoa borealis Dworakowska

Gambialoa borealis Dworakowska, 1981b: 183.

Material Examined : 5 males, Himachal Prades : Chamba, Sultanpur; ex *Mallotus philippiensis*, 21.viii.1986, coll. M. Shenmar.

Tribe Empoascini Distant

7. Empoasca (Distantasca) faciata (Dworakowska)

Distantasca faciata Dworakowska, 1972:25.

Empoasca (Distantasca) faciata (Dworakowska, 1972) Dworakowska, 1980 : 163.
Material Emxmined : males. Punjab, Ludhiana; ex *Cajanns cajan*, 27.viii.1985, coll. J. S· Mann.

8. Ifugoa mikra Dworakowska & Pawar
Ifugoa mikra Dworakowska & Pawar, 1974 : 587.

Material Examined : 1 male, Punjab, Ludhiana; ex *Oryza sativa*, 9.vi.1985, coll. M. Shenhmar.

9. Usharia mata Dworakowska
Usharia mata Dworakowska, 1977 : 18.
Material Examined : 1 male, Himachal Pradesh: Simla, Tara Devi; ex *Coriaria nepalensis*, 14.v.1986, coll. M. Shenhmar.

HARBOURING/HOST PLANTS

Tribe Dikraneurini McAtee

1. Karachiota azadirachtae Ahmed

Material Examined : 20 males 10 females, New Delhi, Buddha Jayanti Park; ex *Azadirachta indica*, 26.x.1985, coll. M. Shenhmar.

2. Motschulskyia (Togaritettix) serrata (Matsumura)

Material Examined: 10 males 10 females, New Delhi, Sunder Nagar Nursery; ex *Rosa indica*, 30.x.1985, coll. M. Shenhmar.

Tribe Erythroneurini Young

3. Helionidia karachiensis Ahmed & Khokhar

Material Examined : 30 males 40 females Punjab, Ludhiana; ex *Acacia catechu*, January—April, 1985, coll. M. Shenhmar; 1 male 6 females, Jalandhar, Phillaur; ex *Acacia nilotica*, 11.iii. 1985, coll. M. Shenhmar

4. Thaia (Nlunga) indica (Ramakrishnan & Menon)

Material ExaMined : 9 males 2 females, Punjab : Kapurthala, Phagwara; ex *Tamarindus indica*, 4.x.1985, coll. M. Shenhmar.

5. Zygina (Hypericiella) *bicornia* Dworakowska

Material Examined : 15 males 15 females, Himachal Pradesh : Solan, Kasauli; ex *Spiraea* sp., 7.v.1985, coll. M. Shenhmar.

Tribe TYPHLOCYBINI Oudemans

6. Baaora variata (Ahmed)
Typhlocyba variata Ahmed, 1971b : 194.
Baaorh variata (Ahmed, 1971) Dworakowska, 1981a : 597.
Typhlocyba neelamensis Ahmed, Naheed & Samad, 1981 : 92, syn.

Material Examined : 20 males 30 females, Uttar Pradesh : Dehra Dun, Mussoorie; ex *Aesculus indica*, 6.x.1985, coll. A. S. Sohi & J. S. Mann; 40 males 80 females, Himachal Pradesh : Solan, Kasauli; ex *A. indica*, 26.x.1985, coll. A. S. Sohi & J. S. Mann

Tribe Empoascini Distant

7. Jacobiasca furcostylus (Ramakrishnan & Menon)

Material Examined : 75 males, Punjab, Ludhiana; ex *Ricinus communis* 14.iii. 1985, coll. A. S. Sohi & J. S. Mann.

Acknowledgements; The authors are grateful to the Professor and Head, Department of Entomology, Punjab Agricultural University, Ludhiana for providing the necessary research facilities and to the Indian Council of Agricultural Research, New Delhi for the financial assistance.

REFERENCES

AHMED, M. (1970) Further Studies on the leafhoppers of tribe Erythroneurini (Cicadellidae:Typhlocybinae) from West Pakistan. *Pakist. J. Zool.*, 2(2), 167—184.

AHMED, M. (1971a) Studies on the genera and species of tribe Erythroneurini (Cicadellidae : Typhlocybinae) from East Pakistan. *Pakist. J. Zool.*, 3(2), 175—192.

AHMED, M. (1971b) Study of new genus and some species of *Typhlocyba* Germar (Typhlocybini : Cicadellidae) in West Pakistan. *J. Sci. Univ. Karachi*, 1(1); 190—202.

AHMED, M. & K. F. KHOKHAR (1971) Genus *Helionidia* Zachvatkin (Erythroneurini ; Cicadellieae) with four new species from West Pakistan. *Univ. Stud. Res. J. (Sci. Ser.)*; 5 (1), 63—72.

AHMED, M., R. NAHEED & K. SAMAD (1981) On some species of the genus *Typhlocyba* from Pakistan (Homoptera, Cicadellidae, Typhlocybinae). *Reichenbachla Mus. Tierk.* Dresden, **19**(16), 89—95.

DWORAKOWSKA, I. (1972) On some Oriental and Ethiopian genera of Empoascini (Auchenorryncha, Cicadellidae, Typhlocybinae). *Bull. Acad. pol. Sci. Cl. II. Ser. Sci. Biol.*, **20**(1), 25—34.

DWORAKOWSKA, I. (1977) On some Typhlocybinae from Vietnam (Homoptera : Cicadellidae). *Folia Ent. Hungarica*, **32**, 9—47.

DWORAKOWSKA, (1979) On some Typhlocybinae from India and adjoining areas (Homoptera, Auchenorrhyncha, Cicadellidae). *Reichenbachia Mus. Tierk. Dresden*, **17** (18), 143—162.

DWORAKOWSKA, I. (1980) On some Typhlocybinae from India (Homoptera, Auchenorrhyncha, Cicadellidae). *Ent. Abh. Mus. Tierk. Dresden*, **43**(8), 151—201.

DWORAKOWSKA, I. (1981a) On some Typhlocybinii from India and Nepal (Auchenorrhyncha, Cicadellidae, Typhlocybinae). *Bull. Acad. pol. Sci. Cl. II. Ser. Sci. Biol*,, **28** (10—11), 593—602.

DWORAKOWSKA, I. (1981b) On some Typhlocybinae from India, Sri Lanka and Nepal (Homoptera, Auchenorrhyncha, Cicadellidae). *Ent. Abh. Tierk. Dresden*, **44** (8), 153—202.

DWORAKOMSRA, I. & A. D. PAWAR (1974) Six new oriental species of Typhlocybinae (Auchenorryncha, Cicadellidae). *Bull. Acad. Pol. Sci. Cl. II. Ser. Sci. Biol.*, **22** (9), 583–590.

DWORAKOWSKA, I. & C. A. VIRAKTAMATH (1975) On some Typhlocybinae from India (Auchenorrhyncha, Cicadellidae). *Bull. Acad. Pol. Sci. Cl. II. Ser. Sci. Biol.*, **23**(8), 521—530.

SOHI, A. S. & I. DWORAKOWSKA (1984) A review of the Indian Typhlocybinae (Homoptera, Cicadellidae) from India. *Oriental Ins.*, **17**, 159—213.

Entomon, 1987, *Vol.* **12**, *No.* 3, *pp.* 305 *to* 308

FIRST RECORD OF MALES FOR FIFTEEN ORIENTAL SPECIES OF *TENTHREDO* LINN. (HYMENOPTERA : TENTHREDINIDAE) FROM INDIA

DEVINDER SINGH & MALKIAT S. SAINI

Department of Zoology, Punjabi University, Patiala, India 147 002

(Received 28 April 1986)

Males for fifteen species of *Tenthredo*, which were known to date by their females, are reported for the first time from India. The characters exhibiting significant sexual dimorphism are also discussed. In addition, the distribution and number of specimens examined for each species have also been provided.

(Key words : First record, males, oriental *Tenthredo*)

INTRODUCTION

Large number of *Tenthredo* species are so far known by their females only. Malaise (1945) suggested thelytoky as the possible reason for non-availability of males. In the present study males for 15 already known species are reported for the first time. Occurrence of remarkable sexual dimorphism with respect to colour and size is a common phenomenon in these sawflies. In several cases both the sexes were caught during copulation stage and thus it became quite easy to establish their relationship.

1) T. aericeps Konow, 1907

Differences from female : Whitish lateral spot on clypeus and medial on labrum; frontside of distal 2/3 of profemur and tibia, dirty white. Average length, 11.4mm.

Dristribution : India–Sikkim, Himachal Pradesh, Uttar Pradesh.

Material examined : 1♂, Himachal Pradesh; Narkanda 2080m, 24.v.1984. 2♀♀, 7♂♂, Uttar Pradesh; Chopta–3000m, 13.vi.1985; 7♀♀, 6♂♂, Uttar Pradesh; Gobindghat–2400m, 20.vi.1985.

2. T. angustiannulata Malaise, 1945

Difference from female : Antenna reddish brown barring black upperside of basal 3 joints; thorax black except tegula; trochanters along with bases of femora, black; posterior slope of mesoscutellum with confluent punctures. Average length 9.3 mm.

Distribution : India – West Bengal, Himachal Pradesh, Uttar Pradesh; Burma; Bhutan.

Material examined : 62 ♀♀, 37 ♂♂, Himachal Pradesh; Kalatop–2308m, 1–15. 7.1984. 15♀♀, 8♂♂, Himachal Pradesh; Kufri–2400m, 28.v.1984. 19♀♀, 7♂♂, Uttar Pradesh; 2050m, 10–12.vi.1963. 5♀♀, 11♂♂, Uttar Pradesh; Gobindghat–2100m, 14.vi.1984.

3. T. annandalei (Rohwer, 1915)

Differences from females: Similar to female in colour, structure and sculpture. Average length, 13.8 mm.

Distribution : India – Sikkim, West Bengal; Bhutan; Nepal.

Material examined : 34♀♀, 16♂♂, Sikkim; Gangtok – 1770m, 7–11.v.1985. 11♀♀, 20♂♂, Sikkim; Mangan – 1200m, 13–15.v.1985.

4. T. assamensis Konow, 1898

Differences from female: Similar to female in colour, structure and sculpture. Length, 13 5 mm.

Distribution: India–Meghalaya, Jammu and Kashmir.

Material examined: 1♀, 1♂, Meghalaya; Smit–1750m, 3.v.1985.

5. T. concinna Mocsary, 1883

Differences from female: Clypeus entirely pale; pale spot on temple continuous with lower hind orbit; meso– and metascutelli without black; large pale spot on mesosternum; abdominal segments 2—5 without black; frontside of mesofemur pale. Average length, 10.7mm.

Distribution : India–Sikkim, Himachal Pradesh, Uttar Pradesh, Meghalaya; Burma.

Material examined: 5♀♀, 1♂ Himachal Pradesh; Kalatop–2485m, 24.vii.1983. 4♀♀, 3♂♂, Meghalaya; Smit – 1820m, 4 v.1985. 12♀♀, 1♂, Uttar Pradesh; Mandal – 2300m, 21.vi.1985. 2♀♀, 1♂, Uttar Pradesh: Hanumanchatti–2600m, 2.vi 1983.

6. T. frontatus Malaise, 1945

Differences from female: All terga with whitish narrow hind margin and sterna dirty yellow; metafemur with whitish stripe on frontside. Average length, 8.7mm.

Distribution : India – Uttar Pradesh; Himachal Pradesh; Burma.

Material examined: 5♀♀, 3♂♂, Uttar Pradesh; Mandal–2300m, 20.vi.1983. 1♀, 1♂, Himachal Pradesh; Kalatop–2550m, 15.vii.1984.

7. T. heinzi Muche, 1982

Differences from female : Longitudinal black stripe on terga 2–3 and triangular spot on 2–4 are absent. Length, 10.7mm.

Distribution: India–Himachal Pradesh, Uttar Pradesh.

Material examined: 2♀♀, 1♂, Uttar Pradesh: Chopta–3000 m, 15.vi.1985. 1♀, Himachal Pradesh; Manali—2700m, 29.v. 1984.

8. T. hingstoni Malaise, 1945

Defferences from female : Antennal segments 4–9 luteous with black outer stripe; mesepisternum and sternum without black; abdomen without black except narrow anterior, margin of propodeum; legs without black; head faintly narrowing behind eyes. Length, 11.0 mm.

Distiibution: India–Himachal Pradesh; Tibet.

Material examined : 1♀, 1♂, Himachal Pradesh; Kothi–2675m, 2.vi.1984.

9. T. lagidina Malaise, 1945.

Differences from female : Labrum entirely yellow; underside of abdomen yellowish; tarsi brownish black except proximal ends of basitarsi; abdominal terga 5 and 6 with tuft of hair on lateral side and 7 with transverse ridge; metabasitarsus swollen. Average length, 11.1mm.

Distribution : India–Himachal Pradesh, Uttar Pradesh, Sikkim; South China.

Material examined: 6♀♀, 3♂♂, Himachal Pradesh; Kalatop–2550m, 26.vii.1982. 3♀♀, 3♂♂, Uttar Pradesh; Mandal–2300m, 13–15.vi.1985. 5♀♀, 3♂♂, Sikkim; Gangtok–1770m, 14.v.1983.

10. T. latifasciata Cameron, 1877,

Differences from female : Lateral side of tergum 2 and abdominal segments 3–5 entirely, reddish brown; bases of femora

more distinctly infuscated. Average length, 11.0 mm.

Distribution: India–Himachal Pradesh, Uttar Pradesh.

Material examined: 25♀♀, 1♂, Himachal Pradesh; Kalatop-2380m,1-15.vii.1984. 9♀♀, 1♂, Uttar Pradesh; Gobindghat–2100m, 22.vi.1985.

11. T. opposita (Smith, 1878)

Differences from female: Triangular pale spot on lower hind orbit; one pale spot each on anterior and posterior margins of tegula. Average length, 9.8mm.

Distribution: India–Himachal Pradesh, Uttar Pradesh, Jammu & Kashmir.

Material examined: 57♀♀, 41♂♂, Himachal Pradesh; Kalatop–2400m, 1–25. vii.1983. 3♀♀, 4♂♂, Himachal Pradesh; Kufri–2500m, 25.iii.1985. 7♀♀, 8♂♂ Uttar Pradesh; Flower valley–3300M, 21.vi.1985. 4♀♀, 2♂♂, Jammu and Kashmir; Gulmarg–2800m, 27.vi.1984.

12. T. scintillans Malaise, 1945.

Differences from female: Labrum entirely and lateral spot on clypeus are whitish; profemur sordid white from frontside.

Distribution: India—Uttar Pradesh; China.

Material examined: 1♀, 1♂, Uttar Pradesh; Chopta–3000m, 14.vi.1985.

13. T. simlaensis Cameron, 1899.

Differences from female: Scape and mesosternum pale green; proleg entirely pale green except spot near distal and proximal ends of femur and tibia respectively; mesotrochanter without black. Average length, 10.5mm.

Distribution: India—Uttar Pradesh, Himachal Pradesh, Sikkim; Burma.

Material examined: 27♀♀, 23♂♂, Uttar pradesh; Mandal–1500m, 7–xi.1985. 25♀♀, 17♂♂, Sikkim; Gangtok – 1770m, 10 v.1985. 11♀♀, 13♂♂, Sikkim; Mangan–1200m, 13–15.v.1985.

14. T. subtilissima Malaise, 1945.

Differences from female: Anterolateral corner of pronotum pale; femur, tibia and tarsus of mesoleg striped with black posteriorly; mesepisternum entirely oily reddish brown; all sterna fulvous; mesepisternum polished. Length, 12.1 mm.

Distribution: India—Sikkim, Uttar Pradesh; Burma.

Material examined: 1♂, Sikkim, Gangtok – 1770m, 15.v.1963. 1♀, Uttar Pradesh; Chopta–3000m, 24.vi.1985.

15. T. waltoni Malaise, 1945.

Differences from female: Fulvous colour breaking through pale of mesepisternum; mesosternum pale; black on tergum 2 absent Average length, 12.2mm.

Distribution: India–Himachal Pradesh, Uttar Pradesh, Sikkim; Tibet.

Material examined: 31♀♀, 8♂♂, Himachal Pradesh; Narkanda–2300m, 27–28. v.1984. 4♀♀, 4♂♂, Himachal Pradesh; Kufri–2500m, 22.v.1984. 2♀♀, 1♂, Uttar Pradesh; Chopta–300m, 16.vi.1985. 2♂♂, Uttar Pradesh; Gobinddham—3000 m, 21.vi.1985.

Acknowledgements. The authors are thankful toDr. D. R. Smith of Systematic Entomology Laboratory c/o USNM, USA, for his perseverant help. The financial assistance provided by the ICAR and DST, New Delhi, is also acknowledged.

REFERENCES

Cameron, P. (1877) Descriptions of new genera and species of East Indian Tenthredinidae. *Trans. ent. Soc. Lond.*, Part II, 87—92.

Cameron, P. (1899) Hymenoptera Orientalia, or a knowledge of the Hymenoptera of the Oriental Zoological Region. Part VIII. The Hymenoptera of Khasia Hills, First paper. *Mem. Proc. Manch. Lit. Phil. Soc.*, **43** (3), 220pp.

MOCSARY, A. (1883) Hymenoptera nova europea et exotica. *Magy. Akad. Term. Ertek.*, **13**, 1—72.

MUCHE, W. H. (1982) Beitrag zur Blatwespenfauna von India und Pakistan, mit Beschreibung einer neuen Art sowie unterart (Hymenoptera, Symphyta, Tenthredinidae). *Reichenbachia*, **20** (15), 113—117.

KONOW, F. W. (1898) Neue asiatische Tenthrediniden (Hymenoptera). *Ent. Nachr.*, **24**, 86—93 and 105—109.

KONOW, F. W. (1907) Neue chalastogastra sus den nathist Museen in Hamburg und Madrid. *Zeit. Hymen. Dipt.*, **7**, 161—174.

MALAISE, R, (1945) Tenthredinoidea of South-eastern Asia with a general Zoogeographical review. *Opus. Ent. Suppl.*, **4**, 288 pp.

ROHWER, S. A. (1915) Some oriental sawflies in the Indian Museum. *Rec. Ind. Mus. Calcutta*, **11**, 39—53.

SMITH, F. (1878) Scientific results of the 2nd Yarkand Mission, based upon the collection and notes of the late F. Stoliizka : Published by the order of the Govt. of India, Calcutta, 4—22, 22 plts.

Entomon; 1987, *Vol.* 12, *No.* 4, *pp.* 309 *to* 313

APHIDOCOLOUS ANTS (HYMENOPTERA : FORMICIDAE) IN MANIPUR

C. MANMOHINI DEVI & T. K. SINGH

Entomology Research Unit, Department of Life Sciences, University of Manipur, Canchipur, Imphal, India 795 003

(Received 2 February 1986)

Three genera and five species of ants are reported here as new records in respect to their aphid association from India. In addition, 3 species of aphid are reported here as myrmicophiles for the first time.

(Key words: new records, ants, aphids, association)

Aphidocolous ants occurring in India are known through the works of Roy & Behura (1980), Kurl & Misra (1980), Datta *et al.* (1981, 1982), Datta & Raychaudhuri (1983, 1984). As a result, 52 species are known so far from India. However, Manipur, a north-eastern state of India has received no attention in this regard.

Extensive surveys are being made for the said purpose in the different parts of the state since 1983. Examination of a part of the material collected so far revealed the existence of 3 genera and 5 species of ants as new records from India in respect to their aphid association. Besides, 3 species of aphid are found as new myrmicophiles for the first time. The new records of aphidocolous ant genera have been marked with single (*), those of aphidocolous ant species by double (**) and those of myrmicophilous aphid species by triple (***) asterisks.

Ant species	aphid species	host plant	place & date	material examined (workers)	remarks
Subfamily—Formicinae					
** *Anoplolepis longipes* Jerdon	*Aphis gossypii* Glover	*Eupatorium odoratum*	Manipur : Iroisemba, c 790m., 22.vii.1985; Chandel, c 1000m., 22.x.1985.	6	distribution : all over India except arid & dry parts (Bingham, 1903)

Ant species	aphid species	host plant	place & date	material examined (workers)	remarks
		Gynura angulosa *Osbechia chinensis*	Manipur : Chandel, c 1000 m., 22.x.1985	3	
	Aphis citricola (V. D.Goot)	*Cynura angulosa* *Bidens pilosa* *Mekauia* sp.	Manipur : Chandel, c. 1000 m., 22.x.1985	9	This ant species is found to tend a large number of aphid species on different host plants.
	Dactynotus sonchi (Linnaius)	*Blumia aromatica*	Manipur : Chandel, c 1000 m., 23.x.1985	3	
	*** *Holotrichosiphon dubius* (V. D. Goot)	*Quercus dealbata*	Manipur : Chandel, c 1000 m., 23.x.1985	2	
	Toxoptera odinae (V. D. Goot)	*Rhus similiata*	Manipur : Iroisemba, c 790 m , 22.vii.1987	3	
** *Polyrhachis convexa* Roger	*** *Holotrichosiphon dubius* (V. D. Goot)	*Quercus dealbata*	Manipur : Iroisemba, c 790 m., 22.vii.1985	3	Earlier it was known from Sri Lanka (Bingham, 1903)
** *Polyrhachis halidayi* Emery	*Aphis gossypii* Glover	*Cynura angulosa*	Manipur : Chandel c 1100 m., 23.x.1985	3	It was earlier reported from Burma, making nests among the leaves of trees (Bingham, 1903)
** *Paratrechina bengalensis* Forel	*Aphis gossypii* Glover	*Eupatorium odorarum*	Manipur : Chandel, c 1000 m., 22.x.1985	5	

Ant species	aphid species	host plant	place & date	material examined (workers)	remarks
		Cynura angulosa			
	*** *Eulachnus thunbergii* HRL	*Pinus khasia*	Manipur : Mao, c 1750 m., 23.i.1985	2	
Paratrechina longicornis	*Aphis citricola* (V. D. Goot)	*Cynura angalosa*	Manipur : Uripok, c 780 m., 10.ii.1985	3	This ant species has been reported by Kurl & Misra (1980) from Assam attending on *Aphis gossypii* Glover.
	Myzus persicae Suker	*Lycoper-sicum esculatum*	Manipur : Imphal, c 780 m., 10.ii.1985	2	
	Toxoptera aurantii (B. d. F)	*Sesanum indicum*	Manipur : Chandel, c 1000 m., 22.x.1985	4	
	Toxoptera citricidus (Kirkaldy)	*Citrus lemonia*	Manipur : Imphal, c 780 m., 28.xii.1984	5	
Sub-family – Myrmicinae					
Cataulacus simoni Emery	*Lachnus tropicalis* (V. D. Goot)	*Quercus dealbata*	Manipur : Chandel, c 1000 m., 22.x.1985	4	Bingham (1903) recorded the distribution of this ant species from Sri Lanka.
Crematogaster flava Forel	*Aphis citricola* (V. D. Goot)	*Eupatorium odoratnm*	Manipur : Churach-andpur c 900 m., 9.x.1983	2	Distribution of this species in India is known from Assam, Sikkim, Orissa

Ant species	aphid species	host plant	place & date	matreial examined (workers)	remarks
	Aphis gossypii Glover	*Psidium guajava*	Manipur : Senapati, c 790 m., 2.x.1983	3	and Travancore (Bingham, 1903).
	Lachnus tropicalis (V. D. Goot)	*Quercus dealbata*	Manipur : Androkhunou c 790 m., 2.x.1983	3	
	Toxoptera odinae (V. D. Goot)	*Rhus similiata*	Manipur : Litan, c 890 m., 4.xi.1983	3	
**Liomyrmex* sp.	*Aphis citricola* (V. D. Goot)	*Wendlandia glabrata*	Manipur : Chandel, c 1115 m., 23.x.1985	4	
Laphomyrmex quadrispinosus Jerdon	*Aphis citricola* (V. D. Goot)	*Wendlandia glabrata*	Manipur : Chandel, c 1000 m., 22.x.1985	3	Distributed in Maharashtra, Orissa, Sikkim, Uttar Pradesh and West Bangal (Bingham, 1903)
	Toxoptera odinae (V. D. Goot)	*Rhus similiata*	Manipur : Litan, c 890 m., 4.xi.1983	2	
Meranoplus bicolor Guer	*Aphis gossypii* Glover	*Eupatorium odoratum*	Manipur : Chandel, c 1000 m., 22.x.1985	3	Bingham (1903) reported distribution of this ant species from Central India & Punjab.
Monomorium glyciphilum Smith	*Aphis gossypii* Glover	*Eupatorium odoratum*	Manipur : Chandel, c 1000 m., 22.x.1985	3	
	****Dactynotus sonchi* (Linnaeus)	*Cynura anoulosa*	Manipur : Chandel, c 1000 m., 22.x.1985		

Acknowledgements. Authors are grateful to Mrs. R. MATHEW, Zoological Survey of India, for identification of some of the ant species. Thanks are due to the Head of Life Sciences Department for working facilities and CSIR, New Delhi, for partly financing the project.

REFERENCES

BINGHAM, C. (1903) *The Fauna of British India, including Ceylon* and *Burma*. (Vol. 2). Published under the Secretary of State for India in Council, London, 506 pp.

DATTA, S. K., D. RAYCHAUDHURI & BASANT K. AGARWALA (1982) Study on aphid tending ants in India—1. *Entomon* **7** (3), 327—328.

DATTA, S. K., D. RAYCHAUDHRI & BASANT K. AGARWALA (1983) Study on aphid tending ants in India—II. *Entomon*. **8** (1), 23—25.

DATTA, S. K. & D. RAYCHAUDHURI (1985) Taxonomy of the Aphidocolous ants (Hymenoptera : Formicidae) of Sikkim & Hilly Areas of West Bengal, *AKITU* **56**, 1—14.

DATTA, S. K. & D. RAYCHAUDHURI (1984) New Aphidocolous Ants (Hymenoptera : Formicidae) from India *Newl. Aph. Soc. India*, **4** (1 & 2) 7.

KURL, S P. & S. D. MISRA (1980) Interaction between the aphids and their attended ants. *J. Environ. Res.*, **1**, 1—6.

ROY, D. K. & BEHURA (1930) Three more spp. of ants attending aphids on *Aphis gossypi* Glover. *Newl. Aph. Soc. India*, **1**, 4.

Entomon, 1987, *Vol.* **12**, *No.* 4, *pp.* 315 *to* 319

CONTROL OF THE RED SPIDER MITE *TETRANYCHUS CINNABARINUS* (BOISD.) ON BETEL VINE

M. SIVAKUMAR & T. MARIMUTHU

All India Co-ordinated Research Project on Betel vine Diseases, (Tamilnadu Agricultural University), Velur, Salem Dist., India 638 182

(Received 2 June 1986)

Field experiments conducted using different acaricidal agents for the control of the red spider mite, *Tetranychus cinnabarinus* (Boisd.) on betel vine for three seasons revealed that ethion (Mit-505 50 EC) as 0.05% spraying recorded maximum knock down of mites followed by dicofol (Kelthane 18 EC) and wettable sulphur (Sulfex 80% W P). Maximum yield of leaves was recorded in the beds sprayed with dicofol followed by monocrotophos, wettable sulphur and ethion. Wettable sulphur was highly economical for the mite control with a cost benefit ratio of 1:28.3.

(Key words: Tetranychus cinnabarinus, control, betel vine)

INTRODUCTION

The red spider mites, *Tetranychus* spp. are polyphagous pests of crops. In betel vine, *Tetranychus cinnabarinus* (Boisd.) is one of the major pests causing over 40 per cent yield loss. The mite population builds up during summer months and forms fine webbings on the under surface of the leaves. The feeding sites of the mites on the leaves become necrotic and sunken with reddish brown colour. In severe cases the entire lamina is affected giving a rusty appearance. The affected areas become silvery due to webbing. The corresponding upper leaf surface shows yellow patches with minute necrotic reddish brown spots. The symptom is described as 'Sevvattai' by local farmers. The varieties 'Karpoori' and 'Karuppu pachai kodi' are highly susceptible while 'Vellai pachai kodi' is fairly free from infestation under field conditions. Several workers have studied chemical control of red spider mites with success in brinjal (SUNDARABABU *et al.*, 1971), field bean (EGUPATHY & PALAISAMY, 1972), jasmine SRINIVASAN *et al.* 1974) and bhendi (SRINIVASAN *et al.*, 1975). But no information is available on the control of 'Sevvattai' in betelvine. Results of the trial undertaken to evaluate some chemicals for the control of the pest are reported below.

MATERIALS AND METHODS

Field trials were laid out in the summer of 1984 at one location and of 1985 at two locations, with the susceptible variety 'Karpoori' in Randomised Block Design replicated thrice. The acaricidal chemicals (see Table 1) were sprayed each at 0.05% concentration and water spray served as control. In all three sprayings after harvest of the leaves at 15 days interval were given during summer months.

Pre-spray mite populations were assessed in each of the treatments having 40 hills, before each spray. The mite population was assessed by randomly collecting ten leaves and the mite population in known areas (1 × 1 cm) marked in the leaf was counted under stereoscopic microscope. Subseqnently leaf samples were collected on 3rd and 10th day after each spray and the per cent reduction in the mite

population over pre-spray population with reference to control calculated. The leaf yield in numbers from each treatment was also recorded. The residue analysis was done for the effective treatments; leaf samples were taken on 1st, 3rd, 5th and 10th day after spray for the analysis.

RESULTS AND DISCUSSION

The observations on the reduction of mites on third day of spraying reveal that all the treatments were significantly superior over control (Table 1). Ethion sprayed beds recorded maximum suppression of mite population and it was significantly superior to other chemicals. Dicofol and wettable sulphur ranked next and were on par. The other chemicals viz., formothion, monocrotophos, phosalone, methyl demeton and dimethoate were less effective and on par in effectiveness,

TABLE 1. Mean* per cent suppression of *T. cinnabarinus* on betel vine three days after spraying with different chemicals, in three experiments.

Acaricidal chemicals	per cent suppression of mite			overall mean
	1984	1985 (location-1)	1985 (location-2)	
monocrotophos	16.54	37.19	35.32	29.68
(Nuvacron 40 EC)	(23.43)	(37.50)	(35.18)	(32.04)
methyldemeton	19.56	26 88	40.11	28.85
(Metasystox 25 EC)	(25.98)	(31.15)	(38.45)	(31.86)
wettable sulphur	25.57	44.34	34.58	34.83
(Sulfex 80 WP)	(30.28)	(41.93)	(35.83)	(36.01)
dimethoate	17.20	29.46	27.48	24.71
(Rogor 30 EC)	(24.00)	(32.61)	(31.16)	(29.39)
formothion	18.73	32.84	35.64	29.07
(Anthio 25 EC)	(25.35)	(34.60)	(36.27)	(32.07)
dicofol	25.38	45.14	44.31	38.28
(Kelthane 18 EC)	(30.08)	(42.01)	(41.25)	(37.78)
ethion	33.20	57.66	56.97	49.28
(Mit-505 50 EC)	(35.11)	(48.49)	(49.35)	(44.32)
phosalone	20.80	35.17	30.69	28.89
(Zolone 35 EC)	(26.83)	(36.06)	(33.19)	(32.02)
Control	0.45	8.29	9.23	5.99
(water spray)	(3.69)	(15.99)	(16.80)	(12.16)

C D Treatments : 3.60 * Mean refers to mean suppression under 3 sprayings. The figures in the parenthesis are transformed values.

TABLE 2. Mean* per cent suppression of *T. cinnabarinus* on betel vine ten days after spraying with different chemicals in three experiments.

Acaricidal chemicals	per cent suppression of mites			overall mean
	1984	1985 (location-1)	1985 (location-2)	
monocrotophos (Nuvacron 40 EC)	25.36 (28.81)	33.86 (35.09)	42.37 (40.31)	33.86 (34.74)
methyldemeton (Metasystox 25 EC)	22.28 (27.74)	37.11 (37.28)	40.51 (39.44)	33.30 (34.82)
wettable sulphur (Sulfex 80 WP)	23.06 (28.45)	39.27 (38.75)	29.14 (31.75)	30.49 (32.98)
dimethoate (Rogor 30 EC)	19.12 (25.85)	31.14 (33.93)	33.42 (34.72)	27.98 (31.50)
formothion (Anthio 25 EC)	15.09 (22.68)	40.85 (39.60)	34.08 (35.51)	30.01 (32.60)
dicofol (Kelthane 18 EC)	30.44 (33.41)	55.84 (48.48)	50.74 (45.77)	45.67 (42.55)
ethion (Mit-505 50 EC)	37.45 (37.60)	59.89 (50.99)	42.45 (40.51)	46.60 (43.03)
phosalone (Zolone 35 EC)	17 80 (24.81)	26.87 (30.68)	33.25 (34.75)	25.97 (30.08)
Control (water spray)	1.24 (5.41)	9.95 (16.41)	7.46 (15.04)	6.22 (12.29)

C D Treatment : 3.66 *Mean refers to mean suppression under 3 sprayings. The figures in the parentheses are transformed values.

The per cent mite reduction recorded on 10th day of spraying also followed a similar pattern (Table 2). Ethion and dicofol were superior over other treatments and were on par. Methyl demeton, monocrotophos, and wettable sulphur ranked next in the descending order.

Considering the yield of betel leaves (in numbers), all the treatments, except phosalone, recorded significantly higher increase in the yield. Maximum yield was recorded in the beds sprayed dicofol which was significantly superior over other treatments. The beds sprayed with monocrotophos, wettable sulphur and ethion ranked next to dicofol and were on par among themselves (Table 3). The residues (Table 4) on the first day after spray were 5.85, 5.39 and 9.46 ppm for wet-

TABLE 3. Yield in number of leaves of betel vine as influenced by control of *T. cinnabarinus* using different chemicals.

Chemicals	mean yield of leaves in numbers (000's)			
	1984	1985 (location-1)	1985 (location-2)	mean
monocrotophos (Nuvacron 40 EC)	3.261	2.126	4.672	3.353
methyl dematon (Metasystox 25 EC)	2.288	1.971	4.406	2.888
wettable sulphur (Sulfex 80% WP)	3.366	2.245	4.362	3.324
dimethoate (Rogor 30 EC)	2.868	1.175	4.087	2.710
formothion (Anthio 25 EC)	2.029	1.724	4.367	2.707
dicofol (Kelthane 18 EC)	4.122	2.610	4.210	3.647
ethion (Mit-505 50 EC)	3.820	1.517	4.152	3.163
phosalone (Zolone 35 EC)	1.518	1.711	4.112	2.447
Control (water spray)	1.005	1.237	3.793	2.012

C D Treatments : 0.638.

TABLE 4. Residues of acaricides in betel leaves.

Sampling days (days after treatment)	residues in ppm (mean)		
	(wettable sulphur)	(ethion)	(dicofol)
1	5.85	5.39	9.46
3	4.65	3.26	5.24
5	5.35	1.05	3.10
10	3.02	0.36	0.92

table sulphur, ethion and dicofol respectively. On 10th day after spray the chemical residues dissipated to 3.02, 0.36 and 0.92 ppm for wettable sulphur, ethion and dicofol respectively.

The use of wettable sulphur was highly economical for the control of the red spider mites with a cost benefit ratio of 1:28.3 (Table 5). It is also safe for use since it is exempted from tolerence limit by Environmental Protection Agency, USA. Further, wettable sulphur could

TABLE 5. Economics of using different chemicals in controlling *T. cinnabarinus* on betelvine.

Treatments	average yield of leaves	yield/ac* in baskets of 2000 leaves	increased yield/ ac over control in baskets of 2000 leavees	profit/ac Rs.	cost of 3 sprayings chemicals+ labour charges	cost benefit ratio
monocrotophos (Nuvacron 40 EC)	3353	540.4	232.2	5805	493.00	1 : 11.8
methyldematan (Metasystox 25 EC)	2588	499.9	151.7	3793	624.00	1 : 6.1
wettable sulphur (Sulfex 80 % WP)	3324	575.4	227.2	5680	201.00	1 : 28.3
dimethoate (Rogor 30 EC)	2710	469.1	120.9	3023	429.00	1 : 7.1
formothion (Anthio 25 EC)	2707	468.5	120.3	3008	519.00	1 : 5.8
dicofol (Kelthane 18 EC)	3647	631.3	283.1	7078	569.00	1 : 12.4
ethion (Mit-505 50 EC)	3163	547.4	199.2	4980	339.00	1 : 14.7
phosalone (Zolone 35 EC)	2447	423.5	75.3	1883	405.00	1 : 4.7
Control	2012	348,2	—	—	—	—

Value of leaves : Rs. 25/2000 leaves (1 basket) * Yield of six picking. Quantity of spray fluid = 500 litres / ac. Labour charge = Rs. 174/per three sprayings.

also be used for the control of powdery mildews in betel vine (ANONYMOUS, 1984).

REFERENCES

ANONYMOUS (1984) "Control of powdery mildew of betelvine". Plant Protection Leaflet, published by AICORP-on Betelvine Diseases, Velur (TNAU).

REGUPATHY, A. & G. A. PALANISAMY (1972) Note on the control of red spider mite, *Tetranychus telarius* on three field bean varieties. *Madras agric. J.*, **59**, 650—651.

SRINIVASAN, P. M., R. GOVINDARAJAN, K. ASAF ALI, A. REGUPATHY & T. R. SUBRAMANIAM (1974) Evaluation of certain acaricides in the control of red spider mite, *Tetranychus telarius* L. on jasmine. *South Indian Hort.*, **22**, 68—69.

SRINIVASAN, P. M., R. GOVINDARAJAN, A. REGUPATHY & T. R. SURRAMANIAM (1975) Evaluation of certain acaricides for control of red spider mites, *Tetranychus telarius* L. on bhendi, *Pesticides*, Sept, 1975. 35.

SUNDARABABU, P. C., P. L. LAKSHMANAN, A. M. HANIFA & C. R. GUNASEKARAN (1970) Insecticidal control trials against the mite, *Tetranychus telarius* on brinjal, *Solanum melongena*. *South Indian Hort.*, **18**, 33—38.

Entomon, 1987, *Vol.* **12**, *No.* 4, *pp.* 321 *to* 323

SENSITIVENESS OF SOME BREEDS OF SILKWORM, *BOMBYX MORI* L. TO KENCHU VIRUS DISEASE BASED ON EXTENT OF COCOONING

R. N. BHASKAR, R. GOVINDAN & M. C. DEVAIAH

Department of Sericulture, University of Agricultural Sciences, G K V K, Bangalore, India 560 065

(Received 2 June 1986)

The per cent cocooning was minimum in case of breeds 'NB_7' (10.76) and 'Pure Mysore' (13.94) while it was maximum (31.42) in 'NB_7' × 'KA' and 'Pure Mysore' × 'NB_4D_2', the former two indicating their high sensitiveness and the latter two hybrids showing their less sensitiveness to kenchu virus disease. With increase in viral dilution, there resulted an increase in cocooning in all the breeds.

(Key words: Bombyx mori; Kenchu virus disease)

INTRODUCTION

Keuchu disease of silkworm, *Bombyx mori* L. has been reported to be a widely prevalent flacherie condition in Karnataka (SHYAMALA, 1978). HADIMANI & SHYAMALA (1983) have proved that this malady is caused by a small, spherical, non-occluded virus measuring 27 × 2 nm in diameter. The relative senstitivity of some breeds of *B. mori* to Kenchu virus disease was tested in laboratory taking into consideration the percentage of cocooning in artificially infected populations and the results are presented in this paper,

MATERIALS AND METHODS

Kenchu virus was purified from experimentally infected silkworms by following the method of INOVE & AYUZAWA (1972) as modified by HADIMANI (1980). The virus stock suspension and its serial dilutions 10^{-1} to 10^{-5}) in Sorensen's phosphate buffer (0.72 M, pH 7.2) were smeared separately and uniformly on to the surface sterilized mulberry leaves cut to size of 12×10 cm and fed separately to 50 newly hatched silkworms of Pure Mysore (PM), NB_7, PM × Kalimpong A, PM × NB_7, PM × NB_{18}, PM× NB_4D_2, PM × C. Nichi, NB_7 × NB_{18} and NB_7 × Kalimpong A and the further feeds were provided with untreated mulberry leaves suitable to the age of the worms. The ripe worms were mounted on bamboo mountage and after five days the cocoons were harvested and counted.

RESULTS AND DISCUSSION

The results on the sensitiveness of the silkworm breeds to Kenchu virus disease as measured by extent of cocooning are discussed below.

The silkworm breed NB_7 showed minimum cocooning of 10.76 per cent followed by PM (13.94), PM×KA (21.13), PM × NB_7 (22.66), PM×NB_{18} (27.99) and PM×C. Nichi (28.37), while NB_7 × NB_{18} recorded 25.37 and both PM×NB_4D_2 and NB_7 × KA 31.42 per cent respectively (Table 1).

Stock suspension fed batches recorded the lowest cocooning (4.14) followed by the dilutions in increasing order and with

TABLE 1. Percentage of cocooning in silkworm breeds as influenced by kenchu virus inoculation.

Viral dilutions	silkworm breeds									
	PM×KA	PM×NB_7	PM×NB_{18}	PM×NB_4D_2	PM× c. nichi	PM	NB_7×NB_{18}	NB_7×KA	NB_7	Mean
Stock suspension	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	13 33 (24.16)	24.00 (28.65)	0 00 (0.00)	4 14 (5.86)
10^{-1}	0.66 (2 71)	0.00 (0.00)	0.00 (0.00)	12.66 (18.50)	21.33 (27.32)	2.66 (5.47)	17.33 (24.16)	26.66 (30.82)	0.00 (0.00)	9.03 (12.10)
10^{-2}	2.66 (9.26)	8.00 (13.51)	2.66 (7.69)	30.00 (32.83)	24 66 (29.33)	6.66 (14.19)	17.33 (24.32)	28.66 (32.36)	0.00 (0.00)	13.40 (18.16)
10^{-3}	13.33 (21.33)	8.00 (16.08)	33.33 (34.44)	35.33 (36.37)	30 00 (33.02)	6.66 (14.19)	22.66 (28.30)	28.66 (32 36)	2.00 (6.55)	19 99 (24.73)
10^{-4}	33.33 (35.18)	28.66 (32.36)	41.33 (39.88)	42.00 (40.30)	30 00 (33.02)	11.33 (16.18)	24.66 (29.33)	28.66 (32.36)	5.33 (13.17)	27.25 (30.19)
10^{-5}	39.33 (38.83)	37.33 (37.51)	53.33 (47.02)	42.00 (40.33)	36.66 (37.05)	15.33 (23.04)	26.00 (30.11)	31.33 (30.08)	7.33 (15.70)	32.07 (33.-9)
Buffer (control)	58.66 (44.22)	76.66 (62.29)	65.33 (54.01)	58.00 (49.60)	56.00 (48.50)	55.00 (47.90)	56.33 (48.60)	52.00 (46.20)	51 33 (19.66)	58.81 (46.77)
Mean	21.13 (21.65)	22.66 (23.10)	27.99 (26.15)	31.42 (31.13)	28.37 (29.74)	13.94 (17.28)	25.37 (29.85)	31.42 (32.26)	10.76 (7.72)	

	S Em. ±	C D at 5%
Silkworm breeds	1.383	34.041
Viral dilutions	1.220	32.343
Interaction	3.660	46.425

Figures in parentheses are transformed values.

10^{-5} dilution, the cocooning was 32.05 per cent.

Stock suspension fed $NB_7 \times NB_{18}$ and $NB_7 \times KA$ yielded 13 33 and 24.00 per cent cocooning respectively and they were same. At 10^{-4}, 10^{-3}, 10^{-2}, 10^{-1} dilutions, maximum and minimum cocooning percentage was obtained from PM × NB_4D_2 (42.00) and NB_7 (5.33); PM × NB_4D_2 (35.33) and NB_7 (2.00); PM × NB_4D_2 (30.00) and PM × KA (2.66), and NB_7 × KA (26.66) and PM×KA (0 66), respectively. On the other hand at highest viral dilution of 10^{-5} the lowest cocooning percentage (7.33) was observed for NB_7, followed by other breeds and no statistical difference existed among the breeds.

With virus stock suspension, NB_7 × NB_{18} gave cocooning to the extent of 13 33 per cent followed by NB_7 × KA (24.00 per cent) and these were the only breeds resulted in cocooning. Similarly, HADIMANI (1980) also observed silkworms exhibiting 100 per cent mortality and resulting in no cocooning when fed with Kenchu viral stock suspension during first instar.

PM×NB_4D_2 showed maximum percentage with 10^{-4} (42.00), 10^{-3} (35.33) and 10^{-2} (30 00) dilutions, while at 10^{-4} and 10^{-5} dilution maximum percentage of cocooning was obtained in both PM× NB_7 and NB_7 × KA (28.66) and PM × NB_{18} (53.33) respectively. Thus, among multivoltine × bivoltine hybrids, PM×NB_4D_2 and among bivoltine × bivoltine hybrids NB_7 × KA were found to be less sensitive to the kenchu virus infection as evidenced by maximum percentage of cocooning yielded by them. Also, the current observation that little or less percentage of cocooning in the breeds with administration of highest kenchu virus concentration is similar as observed by HUNTER & HALL (1968) in *Spodoptera exigua* that the larval mortality increased with the dose of the nuclear polyhedral bodies administered to the host.

REFERENCES

HADIMANI, A. K. (1980) Studies on the nature of Kenchu disease of silkworm, *Bombyx mori* Linnaeus in Karnataka. M. Sc. (Agri.) Thesis, Univ. Agril. Sci., Bangalore, p. 91.

HADIMANI, A. K. & M. B. SHYAMALA (1983) On the nature of Kenchu disease of the silkworm, *Bombyx mori* in Karnataka. *National Seminar on Silk Research and Development*, Central Silk Board, Bangalore, pp. 21.

HUNTER, D. K. & I. M. HALL (1968) Pathogenicity of an NPV of beet armyworm, *Spodoptera exigua*. *J. Invertebr. Pathol.*, **12**, 83–85.

INOVE, H. & C. AYUZAWA (1972) Fluorescent antibody study of infectious flacherie of the silkworm, *Bombyx mori*. *J. Invertebr. Pathol.*, **19**, 227–230.

SHYAMALA, M. B. (1978) Silkworm flacherie in Karnataka. I. Symptomatology. *All India Symposium on Sericultural Sciences, Univ. Agril. Sci.*, Bangalore, pp. 36.

Entomon; 1987, *Vol.* 12, *No.* 3, *pp.* 325 *to* 328

FACTORS ASSOCIATED WITH HOST-LOCATION BY *ALLOXYSTA PLEURALIS* (CAMERON), A HYPERPARASITOID OF *TRIOXYS INDICUS* SUBBA RAO & SHARMA (ALLOXYSTIDAE : HYMENOPTERA / APHIDIIDAE : HYMENOPTERA)

RAJENDRA SINGH & P. N. SRIVASTAVA*

Aphid-Biocontrol Laboratory, Department of Zoology,
University of Gorakhpur, Gorakhpur, India 273 009
*Department of Zoology, Budha P. G. College, Kushinagar (Deoria)

(Received 2 June 1986)

The paper deals with the factors associated with the host location by an alloxystid cynipoid wasp *Alloxysta pleuralis* that hyperparasitises the larvae of the aphidiid wasp *Trioxys indicus*, a primary parasitoid of pigeonpea aphid *Aphis craccivora*. The female after arriving into the potential host-community (host-habitat) locates, at first, the indirect host (aphid) and finally the host proper (parasitoid larvae) for acceptance to oviposit. The host-location is brought about by a summation of olfactory (receptors on antennae) and chemosensory (receptors on ovipositor) stimuli co-ordinated by gustatory (by licking honey dew excreted by the aphid) and visual stimuli. Hyperparasitoid's antennae play a major role in this process.
(*Key words: Alloxysta pleuralis, Trioxys indicus, Aphis craccivora,* host-location, hyperparasitoidism)

INTRODUCTION

Trioxys indicus SUBBA RAO & SHARMA (Aphidiidae : Hymenoptera) is a parasitoid of several *Aphis* spp. (STARY & GHOSH, 1983) and it was found as a very suitable agent against pigeonpea aphid *Aphis craccivora* Koch (Aphididae : Homoptera) (SINGH & SINHA, 1982). SINGH & SINHA (1980) have observed 3% hyperparasitoidism by cynipoids; recently we observed about 10% hyperparasitoidism and identified the hyperparasitoid as *Alloxysta pleuralis* (Cameron) (Alloxystidae : Hymenoptera).

The alloxystid wasps constitute 4th trophic level in an agroecosystem and found only on parasitoids of aphids. Among about 200 species of *Alloxysta* reported (ANDREWS, 1978), only 4 are biologically known (MATEJKO & SULLIVAN, 1979) because of their tiny size and complicated biology. However, the detailed host-selection process is only known for *A. victrix* (Westwood) (= *Charips victrix*). The host-selection is a basic component of host-parasitoid relationship (it does not matter whether the host is of 2nd, 3rd or 4th trophic level). It also determines the capacity of the parasitoid (it may be of 3rd primary ie, 4th secondary or hyperparasitoid ie, or 5th trophic level) species to influence the population dynamics of its host. It is now widely accepted that the parasitoid is at first, attracted towards its potential host-community (host-habitat) by perceiving olfactory stimuli and then to the host for acceptance (WESELOH, 1981). The recognised phases culminating in successful

parasitoidism comprise following : 1. potential host-community-location (host-habitat-location), 2. host-location, 3. host-acceptance, 4. host-suitability, and 5. host-regulation (VINSON, 1984). The entire process has been demonstrated experimentally in some aphidiid parasitoids (primary parasitoids) but is poorly known in case of hyperparasitoids (secondary parasitoids) (GUTIERREZ, 1970a, b, c). In this contribution we have observed and discussed the role of different stimuli that influence the host-location by *A. pleuralis*, *viz.*, visual, gustatory, olfactory and tactile.

MATERIAL AND METHODS

The culture of *A. pleuralis* was maintained on *T. indicus*, the latter was bred on the aphid *A. craccivora* taking *Cajanus cajan* (a legume cultivated for pulse) as a host-plant by the technique mentioned elsewhere (SINGH & SRIVASTAVA, 1986).

The role of various stimuli was studied by defunctioning the concerned receptors as follows:

Role of vision : Eyes of female hyperparasitoids (wasps) (0—3 day old, fed, mated and inexperienced) were coated with black India ink. Each female was introduced into a petri dish (7.5 cm diam.) having infested leaf with 10 hosts (5—7 day post-parasitoidised aphids - PPA) put on moistened Whatman filter paper No. 1 which was placed at the bottom. Following behavioural components of the female were recorded visually as mentioned by PANDEY *et al.* (1982) for 2 hour : 1. time needed to contact the host (host-arrival time), 2. time needed to oviposit after contact (host-handling time), and 3. frequency of antennal contact with and ovipositor thrust into the host (prickings) (Table).

Role of gustation : Since the female wasps are very small in size, the amputation or waxing of their mouth-parts (gustatory receptors) is inconvenient. Therefore, following experimental design was set up : in a petri dish a single fresh leaf of host-plant having 10 hosts (5—7 d PPA) were put on the moistened filter paper placed at the bottom. A single fed, 0—3 day old, mated and inexperienced female wasp was introduced into it for 2 h and the top of the petri dish was covered with glass plated. The observations as mentioned above were taken. Ten replicates were performed (Table).

Role of olfaction and taction : Olfactory and tactile receptors are located on the antennae of the female. The antennactomised (5 segments of each antenna was cut) female (0—3 day old, fed, mated and inexperienced) was introduced into a pteri dish having infested leaf of host-plant with 10 hosts (5—7 d PPA) put on moistened filter paper placed at the bottom and her behaviour was recorded for 2 hour. Ten replicates were performed (Table).

The results of all the three experiments were compared with that of control experiments. For control experiment, a single infested leaf of host-plant with 10 hosts (5—7 d PPA) put in a petri dish on moistened filter paper were exposed for attack by a single fed, 0—3 d old, mated and inexperienced female wasp for 2 h and all her behavioural expressions were noted. The experiment was performed with 10 different females. The results are shown in Table.

To determine the number of hyperparasitoid's egg inside the parasitoid larvae (within the aphid), after 24 h of the experiments the aphids were dissected in saline and the eggs were observed within the haemocoel of the aphid and the parasitoid larvae under high power binocular microscope.

All the experiments were performed at 22—25°C and 60—75% RH.

RESULTS AND DISCUSSION

Once the hyperparasitoid has succeeded in appraoching the potential host-community (host-habitat) the next step followed by her is the location of proper hosts. The factors associated with the host-location comprise various stimuli, *viz.*, vision, gustation, olfaction, taction and acoustic (WESELOH, 1981; VINSON, 1984).

Role of vision : How the vision is responsible in host-location by *A. pleuralis*

TABLE 1. Behavioural responses[1] of *A. pleuralis* against various stimuli during selection of its host *T. indicus*.

Condition of hyperparasitoid	no. of host visited (range)	host-arrival time (sec.)	host-handling time (sec.)	no. of antennal contacts / host	no. of prick host	no. of eggs/ host
Normal	9—10	313±189	360±253	4.5±2.0	2.3±1.3	1.5±0.6
Eyes coated	4—6	495±169*	470±246	3.7±1.8	2.4±1.3	0.6±0.5*
Antennectomised	5—8	734±341*	565±287	3.9±2.3	2.7±1.1	1.6±0.6
Normal, hosts on fresh host-plant-leaf	7—10	613±217*	438±206	3.3±2.1	2.1±0.9	1.3±0.4

[1] Values are presented as mean ± SD; * Significant differences from mean value of normal hyperparasitoid (t-test) ($p \leq 0.01$).

is evident from the table, as blind female approached the host and contacted with it ca. 180 sec. later than the normal ones (when confined in an area ca. 40 sq. cm). Also, the number of hosts visited and the number of eggs laid per host are significantly less in case of blind females than the normal ones (Table). The number of antennal contacts and pricks prior to oviposition per attended host is high for blind wasps. Thus the behaviour of the hyperparasitoid shows that the host-arrival and host-handling time (Table) depend upon the visual stimuli.

Role of gustation : Table displays that the female wasp needs ca. 100% more time in arriving the hosts kept on fresh leaves of the host-plant than that of on infested leaves. The behaviour of the wasp was more or less similar to that of its host *T. indicus* (SINGH & SINHA, 1982). Honey dew present on the leaves when washed with water and the drops of that water when put on a filter paper was found to change the behaviour of the hyperparasitoid in a confined environment. Honeydew not only provide necessary nutrients to the wasps but it also assures them about the probability of the occurrence of the aphids that carry her host inside. Once the hyperparasitoid contacts the aphids, all her activities normalised. Therefore, gustation is partly helpful in host-finding by only reducing the host-arrival time. Similar observations are not known for other hyperparasitoids.

Role of olfaction and taction : It is the well documented fact that the parasitoids in general locate their hosts mostly by responding to a series of environmental stimuli in sequence of steps and these stimuli are predominantly chemical modifiers of parasitoid's/hyperparasitoid's behaviour (VINSON, 1984) known as "kairomones" (BROWN *et al.*, 1970). The role of kairomones for aphidiids has already been established (BOUCHARD & CLOUTIER, 1985). Olfactory and tactile receptors are located on the antennae of the hyperparasitoid. When 5 segments

of both antennae were amputated the wasps needed more time to reach the host than the normal ones (Table). However, she was never observed to attempt oviposition when her antennae were completely removed. Therefore, it seems that the hyperparasitoids also utilise the same chemical cue for locating the aphid hosts as the aphidiids (primary parasitoids) used to do.

The data presented herein furnish considerable insight into the host-location by *A. pleuralis*. It shows that the female after arriving into the potential host-community, locates, at first, the indirect host (aphid) and then the proper host (parasitoid larvae) for oviposition. The host-location is brought about by a summation of olfactory, gustatory and visual stimuli. Hyperparasitoid's antennae play a major role in this process.

Acknowledgements: The authors are grateful to Prof. KRISHNA SWARUP, Head, Department of Zoology, University of Gorakhpur, for facilities and to UGC, New Delhi for financial assistance.

REFERENCES

ANDREWS, F. G. (1978) Taxonomy and host specificity of Nearctic Alloxystinae with a catelogue of the world species. *Occ. Pap. Ent. Calif, Dept. Food Agric. No.* **25**, 128 pp.

BOUCHARD, Y. & C. CLOUTIER (1985) Role of olfaction in host finding by aphid parasitoid *Aphidius nigripes* (Hymenoptera : Aphidiidae). *J. chem. Ecol.*, **11**, 801—808.

BROWN, W. L., T. E. EISNER & R. H. WHITTAKER (1970) Allomones and kairomones : transpecific chemical messengers. *Bioscience*, **20**, 21—22.

GUTIERREZ, A. P. (1970a) Studies on host selection and host specificity of the aphid hyperparasite *Charips victrix* (Hymenoptera: Cynipidae). 3. Host suitability studies. *Ann. ent, Soc. Amer.*, **63**, 1485—1491.

GUTIERREZ, A. P. (1970 b) Studies on host selection and host specificity of the aphid hyperparasite *Charips victrix* (Hymenoptera: Cynipidae). 4. The effect of age of host on the host selection. *Ann. ent. Soc. Amer.*, **63**, 1491—1494.

GUITERREZ, A. P. (1970 c) Studies on host selection and host specificity of the aphid hyperparasite *Charips victrix* (Hymenoptera: Cynipidae). 5. The host selection. *Ann. ent. Soc. Amer.*, **63**, 1495—1498.

MATEJKO, I. & D. J. SULLIVAN (1979) Bionomics and behaviour of *Alloxysta megourae*, an aphid hyperparasitoid (Hymenoptera : Alloxystidae). *J. N. Y. Ent. Soc.*, **87**, 275—282.

PANDEY, R. K., R. SINGH, A. KUMAR, C. P. M. TRIPATHI & T. B. SINHA (1982) Bionomics of *Trioxys (Binodoxys) indicus*, an aphidiid parasitoid of *Aphis craccivora*. 14. Behavioural activities of the parasitoid, associated with its functional response. *Z ang. Ent.*, **93**, 164—175.

SINGH, R. & T. B. SINHA (1980) Bionomics of *Trioxys (Binodoxys) indicus* Subba Rao and Sharma, an aphidiid parasitoid of *Aphis craccivora* Koch. 5. The extent of hyperparasitism. *Z. ang. ent.*, **90**, 141—146.

SINGH, R. & T. B. SINHA (1982) Bionomics of *Trioxys (Binodoxys) indicus* Subba Rao and Sharma, an aphidiid parasitoid of *Aphis craccivora* Koch. 13. Host selection by the parasitoid. *Z. ang. Ent.*, **93**, 64—75.

SINGH, R. & P. N. SRIVASTAVA (1986) Binomics of *Alloxysta pleuralis*, a cynipoid hyperparasitoid of an aphidiid parasitoid *Trioxys indicus*. *Ent. exp. & appl.*, **43**, in press.

STARY, P. & A. K. GHOSH (1983) Aphid parasitoids of India and adjacent countries (Hymenoptera : Aphidiidae). *Tech. Monogr. Zool. Surv. India*, **7**, 1—96.

VINSON, S. B. (1984) The parasitoid-host relationship. in : Chemical Ecology of Insects. Ed. by W. J. BELL & R. T. CADRE. Chapman and Hall, London, 205—233.

WESELOH, R. M. (1981) Host location by parasitoids. in : Semiochemicals : Their role in Pest Control. (Ed. by D. A. NODKUNDL, R. L. JONES & W. J. LEWIS) John Wiely & Sons, New York. 79—95.

Entomon, 1987, *Vol.* 12, *No.* 4, *pp.* 329 *to* 333

THREE NEW SPECIES OF PARASITOIDS (HYMENOPTERH : APHIDIIDAE) FROM INDIA

BASANT K. AGARWALA, J. L. SAHA & S. K. MAHAPATRA

Department of Life Science, Calcutta University Post Graduaate Centre, Agartala, India 799 004

(Received 21 February 1986)

Proan mollitrichosiphi, n. sp. from *Mollitrichosiphum tenuicorpus* (Okajima), *Trioxys ceratovacunae* n. sp. from *Ceratovacuna silvestrii* (Takahashi) and *T. oregmae*, n. sp. from *Ceratovacuna ? perglandulosa* Basu, Ghosh and Raychaudhuri are describrd from India.

(Key words : Aphidiid parasitoids, new species)

INTRODUCTION

Parasitoid association of greenideine and hormaphidine aphids are very poorly known (Mackauer, 1968; Stary, 1970; Stary & Ghosh, 1983). Out of 80 species recorded under Greenideinae from India, 8 species of aphidiid parasitoids were known from 7 species of the subfamily and in case of Hormaphidinae there was no previous record of a parasitoid from any species (Stary & Ghosh, op. cit) although the subfamily is represented by 40 species in India (Agarwla & Ghosh, 1984). Evidently, there is great scope for the search of parasitoids association in the aphids of these two subfamilies where high endemism has been recorded under Indian condition, 78.75% in Greenideinae and 60% in Hormaphidinae (Agarwala & Ghosh, 1985).

Praon mollitrichosiphi, sp. nov.

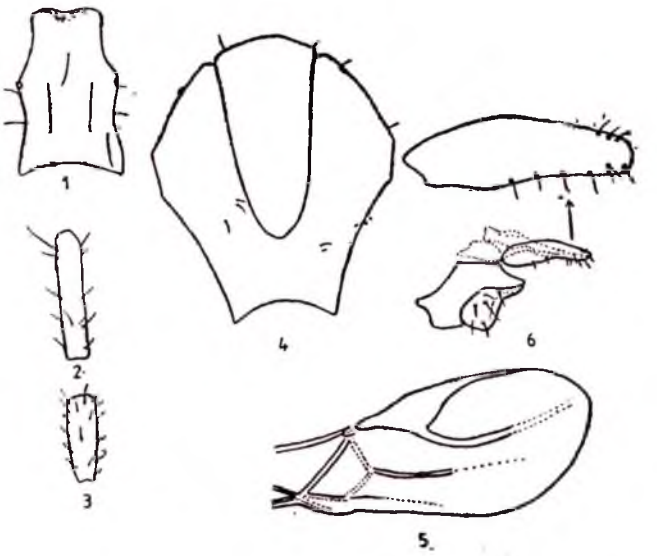
This is the first information on a species of *Praon* parasitizing species of Greenideinae.

The present material is clearly distinguishable from all other known species under the genus by the structure of mesoscutum and host range. But the species shows similarity with *Proan exoletum* (Nees, 1811) in the coloration of scape, pedicel and F_1 and with *P. flavinode* (Haliday) (= *P. glabrum* Stary and Schlinger, 1967) by the tergite I and F_1.

Name of the species is derived from its host.

Female: Head smooth, shiny, wider than thorax at tegulae; hairless face. Gena 1/2 of the eye length. Inter-ocular line less than 1/2 longer than transfacial line, the latter somewhat shorter than facial line. Eyes oval, without hair. Antennae 17-segmented. F_1 5 times as long as wide (Fig. 2); F_2 3 times as long as wide (Fig. 3). F_1 and F_2 without rhinarium. F_2 shorter than F_1. Socket ocularline 1/5 shorter than socket diameter.

Mesoscutum strongly prominent, vertically falling to prothorax, notaulices



Praon mollitrichosiphi, n. sp. Figs. 1. Tergite I; 2. Flagellar segment (F) 1; 3. F 2; 4. Mesoscutum; 5. Forewing; 6. Genitalia.

distinct throughout and hairless (Fig. 4). Propodeum smooth, hairless. Wings: Pterostigma 5 times as long as wide. Metacarpus 1/4 of the Pterostigma (Fig. 5).

Adomen lanceolate. Tergite I longer than wide at spiracles, rugose anteriorly, two hairs on each side below prominent spiracular tubercles; distance between spiracular tubercles longer than distance between spiracular tubercles and apex (Fig. 1). Genitalia: ovipositor sheaths slightly curved upward, nearly slender, pointed at the apex, with sparse hairs (Fig. 6).

Coloration: Head yellowish to light brown; gena, face yellowish; mandibles brown-yellow, palpi yellowish. Antenna: scape, pedicel, F_1 yellowish, rest brown yellow. Thorax yellow; wings hyaline. Abdomen light brown, tergite I light brown. Ovipositor sheaths brown.

Body length: 2.1 mm.

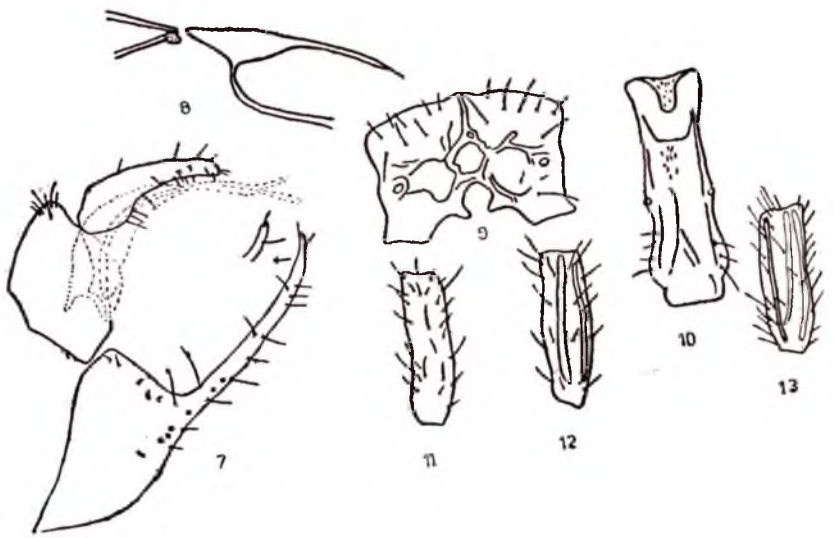
Material Examined: **Holotape:** 1 ♀ Gangtok (*c* 5000 ′), India, 22.xi.1984, ex. *Mollitrichosiphum tenuicorpus* (Okajima) on *Quercus* sp. (Fagaceae) (coll. S. K. Mahapatra). Paratypes: 1 ♀, data same as in holotype.

Trioxys Haliday

Known parasitoid association of Hormaphidinae (Aphididae) is extremely scanty. *Lipolexis oregmae* (Gahan) is known from *Ceratovacuna lanigera* Zehntner and *Calaphidius eleganus* Mackauer (= *watanabe* (Takada) from *Hormaphis betulina shirakabae* Monjen (Mackauer, 1968). This is evidently the first information on two *Trioxys* species parasitizing members of Hormaphidinae in South East Asia.

Trioxys (Binodoxys) ceratovacunae, sp. nov.

New species differ from all other species of Central and Far East Asia



Trioxys (Binodoxys) ceratovacunae, n. sp. Figs. 7. Genitalia; 8. Forewing venation (part); 9. Propodeum, 10. Tergite I; 11. Flagellar segment (F) 1; 12. F2; 13. F4.

under the genus by the shape of propodeum and structure of female genitalia, except some similarity in respect of tergite I and prongs with *T.* (*B.*) ***brunnescens*** Stary and Schelinger, 1967.

Name of the new species is derived from its host species.

Female: Head transverse, smooth, shiny and sparsely haired. Eyes oval (5:3) and prominent, scatteredly haired. Tentorial index 0.33. Gena as wide as 1/3 of longitudinal eye diameter. Interocular line more than double of transfacial line. Socket ocular line less than 1/2 of socket diameter. F_1 4 times as long as wide, without rhinarium, hairs longer than diamater (Fig. 11). F_2 3.3 times longer than width, with two rhinaria (Fig. 12). F_4 with 3 rhinaria (Fig. 13). Antennae 11-segmented. Propodeum (Fig. 9) completely areolated, centrally more or less round areola with two irregular areolae adjacent to tergite I. Radial vein slightly longer than length of pterostigma. Forewings (Fig. 8): Pterostigma little more than 3.5 times as long as wide, metacarpus 1/2 of the radial vein.

Tergite I (Fig. 10) about 3.6 times as long as wide across spiracles, width across primary tubercles 1/6 shorter than width across secondary tubercles. Primary tubercles less prominent. The distance between spiracular and secondary tubercles distinctly greater than width across spiracular tubercles. Genitalia : ovipositor sheaths curved downwards, prongs rather long, slightly arcuate, with 4 long hairs on dorsal surface and one rather thick hair at the apex (Fig. 7).

Coloration : Head deep brown, anteriorly brownish, mouth parts and

parts of clypeus, gena yellowish. Antennae : scape, pedicel, F_1 and base of F_2 yellowish, rest brown. Thorax partly brown and partly yellowish. Wings hyaline, veins brown. Legs : basal part of hind leg brownish, rest yellow. Tergite I brown. Abdominal segments 4, brown anteriorly and light yellow posteriorly. Genitalia : Prongs yellow, ovipositor sheaths light brown.

Body length : 2.6 mm.

Male : Antennae 13-segmented.

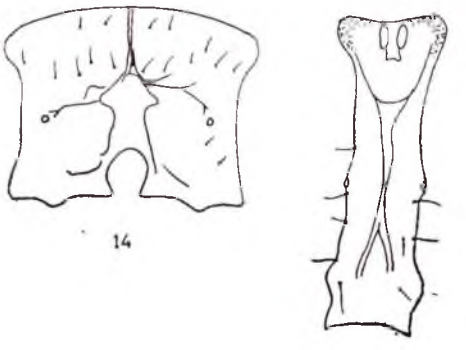
Material examined : **Holotype :** 1 ♀, Sikkim, Gangtok (*c* 5000 ′), India, 16. ii.1985, ex. ***Ceratovacuna silvestrii*** (Takahashi) on a bamoo plant (Coll. S. K. Mahapatra). **Paratype :** 1 ♀, 1 ♂; data same as in holotype.

Trioxys (Binodoxys) oregmae, sp. nov.

This species shows similarity with *T. (B.) ceratovacunae*, sp. nov. but differs from it in the following key characters– Tergite I 3.6 times as long as wide across spiracles; gena as wide as 1/3 of longitudinal eye diameter; propodeum completely areolated, centrally more or less round areola with two irregular areolae adjacent to tergite I. ....*ceratovacunae*, sp. nov. Tergite I 4.0 times as long as wide across spiracles; gena as wide as 1/5 of longitudinal eye dimameter; propodeum triangular, central areola open in the basal. .....*Oregmae*, sp. nov.

Name of the new species is derived from aphid group name.

Female : Head transverse, sparsely haired. Gena as wide as 1/5 of longitudinal eye diameter. Eyes oval (2 : 1) and without hair. Tentorial index 0.3. Interocular line more than twice as long as transfacial line. Clypeus with 3—4 long hairs. F_1 almost equal to F_2. F_1 3.3 times as long as wide, F_2 4 times as long as wide. F_1 with 0—1 rhinarium; pre-apical segment with two rhinaria; apical segment with four rhinaria. Socket ocular line 1/2 of socket diameter. Antennae 11-segmented. Propodeum (Fig. 14) triangular, central areola open in the basal, sparsely haired. Wings : Pterostigma triangular, less than 4 times as long as wide; metacarpus 1/2 of the pterostigma; radial vein little shorter than pterostigma.



Trioxys (Binodoxys) oregmae, n. sp.
Figs. 14. Propodeum; 15. Tergite I.

Abdomen lanceolate; tergite I (Fig. 15) about 4 times as long wide at spiracles, with central longitudinal carina bifurcated in the basal region, anteriorly rugose, with 3—4 hairs on each side. With a spiracular tubercles shorter than width at secondary tubercles. Length between spiracular tubercles shorter than distance between spiracular tubercles and apex. Genitalia : prongs shorter, nearly straight, 3 long hairs on dorsal surface, apically one long hair.

Coloration : Head brown; Gena, mandibles yellow; clypeus yellowish. Wings– hyaline, venation light brown. F_1 yellow, rest light brown to brown. Legs yellowish; propodeum dark brown. Tergite I deep

brown to brownish. Prongs yellow, ovipositor sheaths brown.

Body length : 2.1—2.4 mm.

Material examined : **Holotyye** : 1♀, Sikkim, Gangtok (*c* 5000′), India, 9.ii.1985. ex. *Ceratovacuna* sp. ? ***perglandulosa*** Basu, Ghosh and Raychaudhuri on an unidentified species of grass (coll. S. K. Mahapatra); paratype, 1♂, 2 ♀; data same as in holotype.

Acknowledgements; This work was financed through the research projects sponsored by CSIR and ICAR, New Deihi. Thanks are due to Dr. P. Stary for confirming the novelty of the species and helpful comments in the preparation of this manuscript. The Incharge, Department of Life Science, C U P G Centre deserves thanks for extending necessary working facilites.

REFERENCES

AGARWALA, BASANT K. & A. K. GHOSH (1984) A check-list of Aphidoidea of India. *Rec. Zool. Surv. India, Occ. Paper* no. **50**, 1-71.

AAGRWALA, BASANT K. & M. R. GHOSH (1985) Biogeographical considerations of Indian Aphididae (Homoptera). *Ins. Matsum. n. s.* **31**, 81—96.

MACKAUER, M. (1968) Aphidiidae, Part 3. Hymenopterum catalogus (n. ed.), (edited by FERRIERE C. and V. D. VECHT) Dr. W. Junk N. V. The Hague, 103 pp.

SEARY, P. (1970) Biology of aphid parasites Hymenoptera : Aphidiidae) with respect to integrated control. Series *Entomologica.* 6, Dr. W. Junk N. V., The Hague, 643 pp.

STARY, P. & A. K. GHOSH (1983) Aphid parasitoids of India and adjacent countrles (Hymenoptera : Aphidiidae). *Tech. Mono. 7 Z S I., India*, 96 pp.

Entomon, 1987, *Vol.* 12, *No.* 4, *pp.* 335 *to* 338

EFFECT OF DIFLUBENZURON ON DNA SYNTHESIS IN PUPA OF *CORCYRA CEPHALONCIA* STAINTON[1]

M. SRIRAMULU[2] & K. N. MEHROTRA[3]

(Received 28 June 1985)

DNA synthesis was monitored by assaying the radio activity of [^{3}H] thymidine incorporated into DNA in both diflubenzuron treated and control pupae of *Corcyra cephalonica* Stainton. The rate of [^{3}H] thymidine incorporation increased throughout pupal development. Though there was initial increase in DNA synthesis in diflubenzuron treatment, with progressive increase in age there was 50 per cent inhibition of DNA synthesis in diflubenzuron treated pupa compared to control.

(Key words: DNA synthesis, [^{3}H] thymidine, incorporation, inhibition)

INTRODUCTION

Insect cuticle, a characteristic of class Insecta, can offer an excellent target for the control of insect pests. The new class of insecticides, benzoylphenyl ureas affect this tissue. The essential feature of their mode of action is that they inhibit the deposition of chitin at the time of moulting (ISHAAYA & CASIDA, 1974; DEUL *et al.*, 1978). Inhibition of DNA synthesis by diflubenzuron as revealed by studies on incorporation of labelled thymidine has been reported in *Anthonomus grandis* (MITLIN *et al.*, 1977), *Stomoxys calcitrans* (DELOACH *et al.*, 1981) and *Tenebrio molitor* (SOLTANI *et al.*, 1981). DNA, being the genetic material, is essential for protein synthesis and differentiation of various tissues which symbolises growth. The present investigations, therefore, were undertaken to elucidate the DNA synthesis and to study the effect of diflubenzuron treatment on this parameter in pupae of *C. cephalonica*.

MATERIALS AND METHODS

[Methyl - ^{3}H] thymidine (9.9 m ci/m mol, 2.2×10^6 dpm / μl) was obtained from Bhabha Atomic Research Centre, Bombay, Technical grade diflubenzuron was a gift from Dr. A. B. Borkovec, Insect Chemisterilants Laboratory, United States Department of Agriculture, Beltsville, Maryland, U. S. A. 2,5 - diphenyl oxazole (PPO) and 1,4 -di- (2- (5-phenyloxozolyl) benzene (POPOP) were obtained from Sigma Chemical Company, Missouri, U. S. A. The pupae of *Corcyra cephalonica* Stainton (Pyralidae : Lepidoptera) were obtained from a laboratory colony maintained on broken *Sorghum bicolor* (L.) grains.

Diflubenzuron 0.1 μg / pupa (ED_{80}) was injected at 0 day of pupal age using dimethy formomid : methyl alcohol at 2 : 3 ratio as solvent. Diflubenzuron treated and sham injected pupae were injected with 0.25 μl of [^{3}H] thymidine (0.25 μ ci / 0.25 μ mol) at different age of pupae. The material was injected to pupae with the help of alcohol sterilized 27 gauge needle attached to 1 ml tuberculin syringe using an electrically operated micro - applicator to avoid movement of pupa at the time of injection, they were anaesthetized with chloroform. The pupae were given a 4 h pulse (SELMAN & KAFATOS, 1974) incorporation of labelled

[1] Part of the thesis submitted to P. G. School, I A R I., New Delhi for the award of Ph.D.

[2] College of Agriculture, Rajendranagar, Hyderabad-500 030.

[3] Division of Entomology, I A R I, New Delhi 110 012.

thymidine into DNA. Later ten pupae were sacrificed and DNA was extracted by the method of PRICE (1969).

Assay of radioactivity : [^{3}H] thymidine incorporated into DNA was determined in both diflubenzuron - treated and control pupae by measuring the radio activity in aliquots of extracted DNA in BRAYS (1960) scintillation fluid (naphthalene 60 g, PPO 4 g, POPOP 0.2 g, methanol 100 ml, ethylene glycol 20 ml made to 1 litre using dioxane). Perchloric acid in the sample was eliminated by precipitating it as perchlorate with 1 N KOH (CHOUDHARY & LEMONDE, 1966). For assay of the activity, 10 ml of scintillation mixture and 1 ml of DNA extract were used per vial. The activity was counted using a Kontron Betamatic Liquid Scintillation Counter for one minute. Quench correction was applied by the sample - channels - ratio method using standards with known quenching.

RESULTS

From the data presented in Table 1 it would be seen that the rate of [^{3}H] thymidine incorporation increased throughout the pupal development.

When the data (excluding 3rd day observation which gave abnormal results) was subjected to linear regression analysis by least squares method, it gave a straight line (Fig. 1). The calculated regression equation was

$$Y = 576 \times 106 \times \text{ for control and}$$

$$Y = 716 + 56 = \text{ for diflubenzuron}$$

treated pupae where Y was the rate of thymidine incorpuration in dpm and $\times$ the age of pupa. From the above equations it is apparent that rate of incorporation of [^{3}H] thymidine in control was two-fold higher than in diflubenzuron treated pupae. The rate of [^{3}H] thymidine incorporation per day was 54 dpm / pupa in diflubenzuron treated pupa compared to 106 dpm/pupa in control. These results show a 50 per cent inhibition in the rate of [^{3}H] thymidine incorporation in diflubenzuron treated pupa when compared to control. From equation it would also be seen that diflubenzuron treatment increased the rate of incorporation in freshly treated insects (0 day). At 0 day, the observed rate of incorporation of [^{3}H] thymidine was 556 dpm / pupa in control and 703

TABLE 1. Effect of diflubenzuron [^{3}H] thymidine incorporation into DNA of *Corcyra cephalonica* pupae.

Pupal age (days)	[^{3}H] thymidine incorporation			
	dpm / pupa		dpm / g body weight	
	control	treated	control	treated
0	556 ± 23.6**	703 ± 26.5	15327 ± 127.8**	20506 ± 143.2
1	694 ± 26.3*	790 ± 28.1	20445 ± 143.0**	23382 ± 152.9
2	806 ± 28.4	818 ± 28.6	24308 ± 155.9**	25131 ± 158.5
3	674 ± 26.0*	761 ± 27.6	20798 ± 144.2**	23546 ± 153.5
4	991 ± 31.5	931 ± 30.5	31863 ± 178.5**	29576 ± 172.0
5	1099 ± 33.2*	984 ± 31.4	36495 ± 191.0**	32510 ± 180.3

Each value reported is the mean of 10 pupae with 8 replicates each. * Significant at 5% level. ** Significant at 1% level.

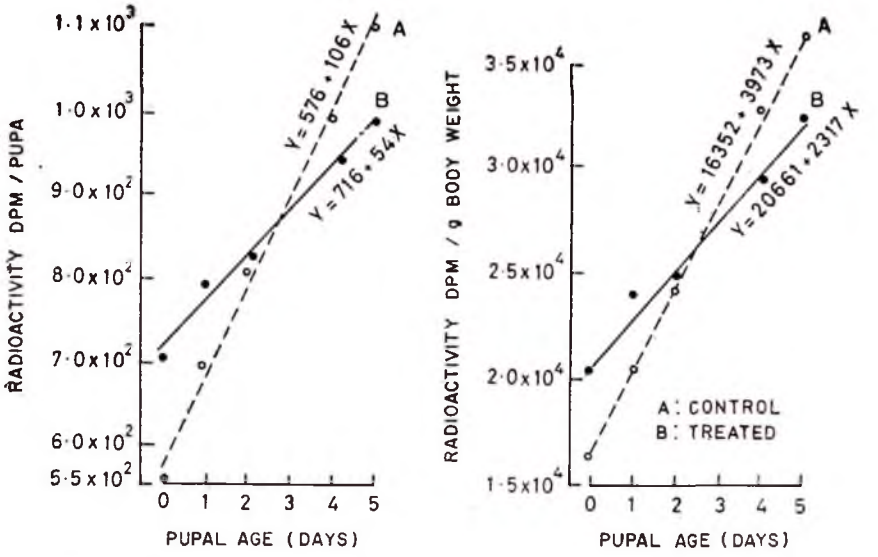


Fig. 1 Effect of diflubenzuron on [³H] thymidine incorporation into DNA of *C cephaloncia*.

Regression equation	A. Control	B. Treated.
dpm / pupa	$Y = 576 + 106 X$	$Y = 716 + 54 X$
dpm / g body weight	$Y = 16.352 + 3973 X$	$Y = 20661 + 2317 X$

dpm/pupa in diflubenzuron treated pupa. With the progressive increase in age there was a decrease in rate of [³H] thymidine incorporation in diflubenzuron treated pupa when compared to control. At the 5th day the rate of incorporation of [³H] thymidine was 1099 dpm/pupa in control and 984 dpm/pupa in diflubenzuron treated pupa. By solving these two simultaneous equations it was observed that the switchover from the higher to the lower rate of [³H] thymidine incorporation in diflubenzuron treated pupa compared to control occurred at 2.7 days of pupal development. The difference in [³H] thymidine incorporation in diflubenzuron treated and control pupa was statistically significant at 0, 1, 3 and 5th day of pupal development.

These results when calculated on rate of incorporation of [³H] thymidine per g body weight followed a similar pattern as seen with individual pupa. But the difference in the rate of [³H] thymidine incorporation in diflubenzuron treated pupae and control was significant at all stages of pupal development. This apparent discrepancy was probably due to loss of weight during pupal development.

DISCUSSION

The rate of [³H] thymidine incorporation suggests that there was a gradual increase in rate of DNA synthesis during pupal development. In early stage of pupal development rate of incorporation of [³H] thymidine was more in diflubenzuron treated pupa than control. Initial increase in rate of synthesis of DNA in diflubenzuron treated pupa might be due to higher rate of metabolism required for the detoxification of the compound and increased respiration caused by insecticide. However, with progressive

increase in age the rate of incorporation of [^{3}H] thymidine decreased in diflubenzuron pupa when compared to control. In diflubenzuron treated pupae the rate of incorporation of [^{3}H] thymidine was 54 dpm / day / pupa compared to 106 dpm / day / pupa in control. The reduction in rate of incorporation in diflubenzuron treatment has led to a lower rate of synthessis of DNA in later stage of pupal development. Inhibition of DNA sythesis by diflubenzuron has been reported in *Anthonomus grandis* (MITLIN *et al.*, 1977), *Stomoxys calcitrans* pupae (DELOACH *et al.*, 1981) and *Tenebrio molitor* pupae (SOLTANI *et al.*, 1984). The inhibition of DNA synthesis at later stages of pupal development could be the effect of toxicant injected to fresh pupae.

Diflubenzuron is characterised by its delayed effects. Freshly formed pupae of *C. cephalonica* when treated show their toxic effects (prevention of eclosion and abnormal wings) only at the time of moulting. Moulting is governed by hormonal system in which corpus allatum, prothoracic gland and eclosion hormone play the major role in pupal–adult transformation. This suggests that diflubenzuron treatment might be affecting either the hormonal system or the mechanism of chitin synthesis at the time of moulting. It is possible that inhibitory effects of diflubenzuron on DNA synthesis seen in these studies are secondary. No firm conclusion can be drawn as to the primary mode of action of these compounds and further work is needed to elucidate their exact mode of action.

REFERENCES

BRAY, G. A. (1960) A simple efficient liquid scintillator for counting aqueous solutions in a liquid scintillation counter. *Anal. Biochem.*, **1**, 279—285.

CHOUDHARY, K. D. & A. LEMONDE (1966) In vivo synthesis and breakdown of deoxyribonucleic acid in *Tribolium confusum* Duval. *Can. J. Biochem.*, **44**, 1571—1575.

DELOACH, J. E., S. M. MEOLA, R. T. MAYER & J. M. THOMPSON (1981). Inhibition of DNA synthesis by diflubenzuron in the pupae of stable fly *Stomoxys calcitrans* (L). *Pestic. Biochem. Physiol.*, **15**, 172—180.

DEUL, D. H., B. J. DE JONG & J. A. M. KORTEXBACH (1978) Inhibition of chitin synthesis by two 1- (2, 6-disubstituted benzoyl)-3-phyenylurea insecticides. II. *Pestic. Biochem. Physiol.*, **8**, 98—105.

ISHAAYA, I & J. E. CASIDA (1974) Dietary TH 6040 alters composition and enzyme activity of housefly larval cuticle. *Pestic. Biochem. Physiol.*, **4**, 484—490.

MITLIN, N., G. WIYGUL & J. W. HAYNES (1977) Inhibition of DNA synthesis in boll weevil (*Anthonomus grandis* Boheman sterilised by Dimilin. *Pestic. Biochem. Physiol.*, **7**, 559—563.

PRICE, G. M. (1969) Protein synthesis and nuclei acid metabolism in the fat body of the larva of the blow fly, *Calliphora erythorocephala*. *J. Insect Physiol.*, **15**, 931–944.

SELMAN, K. & F. C. KAFATOS (1974) Thymidine metabolism and the monitoring of DNA synthesis in insects. *J. Insect Physiol.*, **20**, 513—528.

SOLTANI, N., M. T. BESSON & J. DELACHAMBRE (1984) Effect of diflubenzuron on the pupal adult development of *Tenebrio molitor* L. (Coleoptera : Tenebrionidae). Growth and development, cuticle secretion, epidermal cell density, and DNA synthesis. *Pestic. Biochem. Physiol.*, **21**, 256—264.

Entomon, 1987, *Vol.* **12**, *No.* 4, *pp.* 339 *to* 343

DESCRIPTION OF A NEW SPECIES OF *COCCOSTERPHUS* STAL WITH REVISIONARY NOTES ON THE GENUS (HOMOPTERA : MEMBRACIDAE)

K. S. ANANTHASUBRAMANIAN & L. K. GHOSH*

Department of Zoology, Loyola College, Madras, India

*Zoological Survey of India, Culcutta, India

(Received 21 February 1986)

One new species, *Coccosterphus mysorensis*, is described. The genus *Coccosterphus* Stal is revised, and based upon tegminal, genitalic and nymphal characters, a new genus, *Eucoccosterphus*, is proposed to accommodate those species with distinct tegminal pterostigma, besides other characters. Species devoid of pterostigma are retained in Stal's genus, *Coccosterphus*. Keys to the genera of the tribe Coccosterphini, and to the species of *Coccosterphus* Stal and *Eucoccosterphus* gen. nov. are given.

(Key wrods: Coccosterphus, revision, Membracidae)

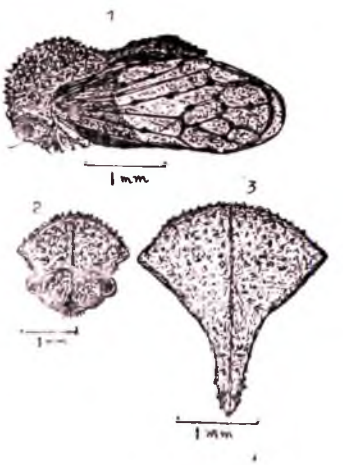
Subfamily *Centrotinae* Spinola
Tribe *Coccosterphini* Distant
Genus *Coccosterphus* Stal

Coccosterphus mysorensis sp. nov. (Figs. 1—3)

Male: General colour pitch black; head nearly 2.75 times as wide as long, thickly granulose, with scattered silvery bristles; eyes hemispherical, pale white; ocelli nearer to eyes than to each other and situated above the centro-ocular line; frontoclypeus slightly extending below lower margins of vertex, sparsely longly pilose, frontoclypeal lobes fused throughout their length. Pronotum black, sprinkled with large tubercles and granules; metopidium nearly vertical to about two-thirds of its height, then obliquely directed backward; humeral angles prominent, their tips subacute; posterior process broadly triangular, moderately raised behind disc; dorsal carina interrupted near the median depressed part of posterior process, apical region laminate, convex above, slightly raised and reaching upto the inner angles of tegmina, tip acuminate, subapical part with a few large tubercles; tegmina devoid of pterostigma, about two and a half times as long as wide, entirely shaded black, basal one-third punctulate, pitch black, coriaceous; first apical cell about thrice as long as its maximum width; first discoidal cell stylate, petiole nearly as long as the length of the cell; second discoidal cell about 1.5 times longer than the first; apical limbus narrow, veins stout, bearing large nodular tubercles, fewer in number; hindwings with three apical cells; legs black upto middle of femora, tibiae yellowish, tarsi pale white. Genitallic structures similar to those of *Coccosterphus minutus* (Fabr.).

Measurements: Length from frontal margin to tips of tegmina 2.7 mm., to tip of posterior process 1.9 mm.; width at humeral angles 1.7 mm., at eyes 1.6 mm.

Material examined: One male collected from Coorg, Mysore, on *Flacourtia* sp. on 24-12-1983.



Coccosterphus mysorensis sp. nov-
1. Lateral view of male; 2. Frontal view; 3 Dorsal viw of pronotum

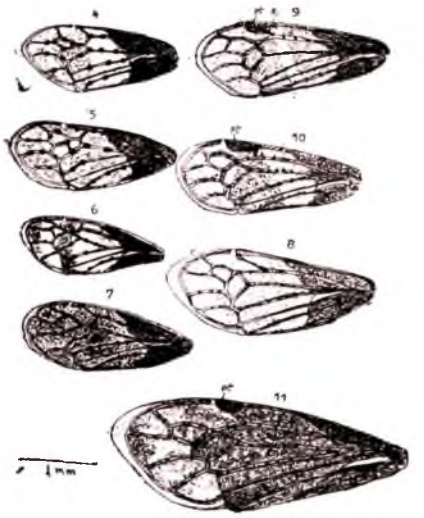
Remarks: *C. mysorensis* is closely related to *minutus* (Fabr.) in the general coloration, size and in the nature of the pronotal posterior process, but differs markedly in the coloration of the tegmina which are completely shaded with black, and also in the shape and length to width relation of the first apical cell of the tegmina.

Revisionary notes on the genus **Coccosterphus**

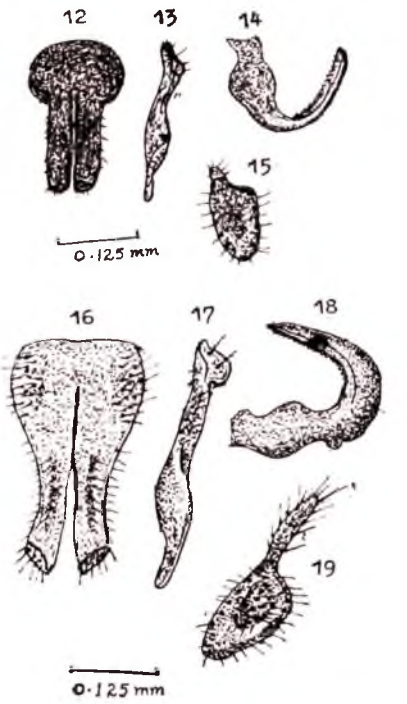
The genus *Coccosterphus* was erected by Stal in 1869. The genus includes small-sized species, more or less oval in shape; the ocelli are nearer to eyes than to each other; the tip of the frontoclypeus is either almost on a line with the lower margins of vertex, or extending to variable degrees below the lower margins of the vertex; the pronotum is finely or coarsely tuberculate; the basal part of the posterior process is broadly triangular, depressed from base to middle, closely fitting against the scutellum and contiguous with the inner margins of the tegmina; the apex of the posterior process is laminate and convex; the scutellum is narrow in the middle; tegminal base opaque and coriaceous. A distinct pterostigma may be present or absent; tegminal veins are either moderately thick, bearing either small or large nodulose tubercles; in the male genitalia, the 'processes' of the lateral valves are either aborted or conspicuously long; the subgenital plate is distinctly broader at base.

Altogether 11 species of *Coccosterphus* are known so far, all being distributed in the Oriental region. Of these, eight species, viz., *minutus* (Fabr.), *obscurus* Dist., *decoloratus* Dist., *mucronicollis* (Motsch.), *paludatus* Dist., *tuberculatus* (Motsch.), *luteus* Funkhouser and *mysorensis* sp. nov., have been recorded from southern India; *melichari* Goding has been recorded from Sri Lanka, while *stipulipennis* (Buckton) and *bengalensis* Ahmad *et al* have been recorded from Borneo and Bangladesh, respectively, The last-mentioned three species could not be included in the present revisionary study of the genus due to their nonavailability for examination.

Examination of the tegminal characters of the different species of *Coccosterphus* from southern India shows that *paludatus*, *tuberculatus* and *mucronicollis* possess a distinct pterostigma formed by a chitinised thickening of the tegminal membrane near R1, while *minutus*, *obscurus*, *decoloratus*, *luteus* ond *mysorensis* lack this structure (Figs. 4—11). The presence or absence of a tegminal pterostigma has been considered as a very important taxonomic character by Capener (1968) who used this structure in the separation of several African genera. Ananthasubramanian and Ananthakrishnan (1975) also



Tegmina of
4. *Coccosterphus minutus*, 5. *C. obscurus;* 6. *C. decoloratus*, 7. *C. mysorensis;* 8. *C. luteus;* 9. *C. tuberculatus;* 10. *C. paludatus;* 11. *C. mucronicollis.*

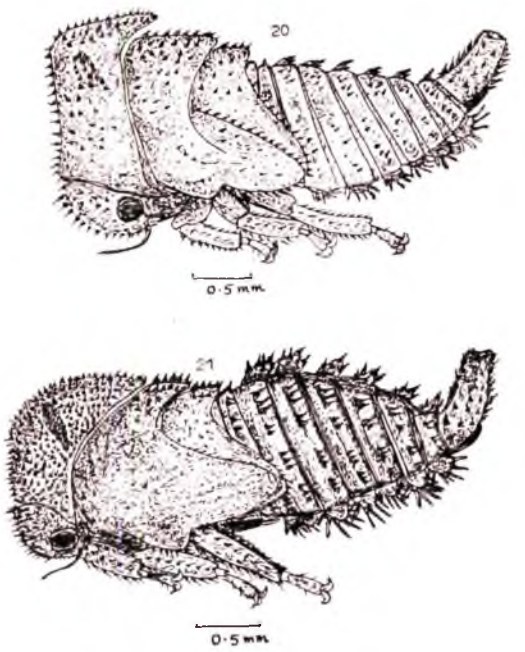


Male genitalia of C. minutus
12. Subgenital plate; 13. Paramere; 14. Aedeagus; 15. Lateral valve with its aborted process (p).

C. tuberculatus
16. Subgenital plate; 17. Paramere; 18. Aedeagus; 19. Lateral valve with its well developed process (P).

stressed the importance of the pterostigma and suggested that the genus *Coccosterphus* may be revised on the basis of this character. Equally essential is the consideration of the genitallic characters of males in this regard. In the male genitalia, the aedeagus, parameres and subgenital plate do not appear to exhibit significant interspecific differences, while the lateral valves show notable differences. In those species of *Coccosterphus* which lack the pterostigma, the 'processes' of the lateral valves are invariably aborted, while in species that possess the pterostigma, the processes of the lateral valves are conspicuously long (Figs. 12—19). The nymphal chaetotaxy is also worth consideration. The nymphs, especially the fifth instars of the species of *Coccosterphus* which are devoid of pterostigma, differ from those possessing the pterostigma in the complexity of tuberosities and spines, those belonging to the former category being simple, in contrst to those belonging to the latter category being provided with large, heavily chitinised dorsal and dorsolateral tubercles and the spines arising from the tuberosities are long and stout (Figs. 20, 21).

The differences in the tegminal characters, when considered in conjunction with the male genitalia and nymphal chaetotaxy, make it necessary to allocate some species, which have so far been included in *Coccosterphus*, to a new genus, *Eucoccosterphus*. Species that lack a tegminal pterostigma and in which the processes of the lateral valves of the male genitalia are aborted, and which



Fifth nymphal instars of 20. *C. minutus*; 21. *C. tuberculatus*.

show relatively simple chaetotaxy in their nymphal stages, are retained in Stal's genus *Coccosterphus*, the type of this genus being *minutus* (Fabr.). Species which possess a distinct tegminal pterostigma and in which the processes of the lateral valves are conspicuously long, and which show large, heavily chitinised thoracic and abdominal dorsal and dorsolateral tubercles and spines in their nymphal stages, are allocated to the new genus, *Euccosterphus* the type of the genus being *mucronicollis* (Motsch).

KEY TO THE GENERA OF THE TRIBE COCCOSTERPHINI DISTANT

1(4) Pronotum tuberculous, posterior process concavely depressed at base and laminately convexly raised at apex.

2(3) Tegmina devoid of pterostigma, tegminal veins very thick, bearing large, nodular tubercles, fewer in number; processes of the lateral valves of male genitalia aborted.....*Coccosterphus* Stal

3(2) Tegmina with distinct pterostigma, tegminal veins moderately thick, bearing numerous small nodular tubercles; processes of lateral valves of male genitalia conspicuously long.....*Eucoccosterphus* gen. nov.

4(1) Pronotum not tuberculous; posterior process straight, neither concavely depressed at base, nor laminately convexly raised at apex.

5(6) Posterior process short, slender and recurved, its apex not reaching the postrior angle of the inner margin of the tegmina .....*Yasa* Distant

6(5) Posterior process broad at base, acutely narrowed on its apical area, its apex reaching or slightly passing the posterior angle of the inner margin of the tegmina .....*Kanada* Distant

KEY TO THE SOUTH INDIAN SPECIES OF *COCCOSTERPHUS* STAL

1(4) Frontoclypeus extending only slightly below the lower margins of vertex; tip of posterior process acuminate, its subapical part with a few large tubercles.

2(3) Tegmina greyish flavescent, its apical area tinted reddish brown patches; 1st apical cell about twice as long as its maximum width.....*minutus* (Fabr.)

3(2) Tegmina uniformly shaded with black; 1st apical about thrice as long as its maximum width.....*mysorensis* sp. nov.

4(1) Frontoclypeus extending well below the lower margins of vertex; tip of posterior process not acuminate, subapical part of posterior process devoid of large tubercles.

5(8) Pronotum black; tegmina variable in colour and pattern, tinted with black or brown patches or spots.

6(7) 1st discoidal cell of tegmina nonpetiolate.....*obscurus* Dist.

7(6) 1st discoidal cell of tegmina distinctly petiolate.....*decoloratus* Dist.

8(5) Pronotum pale yellow; tegmina more or less hyaline, devoid of black or brown patches or spots.....*luteus* Funk.

KEY TO SOUTH INDIAN SPECIES OF *EUCOCCOSTERPHUS* gen. nov.

1(2) Apex of posterior process not reaching the posterior angle of the inner margin of the tegmina; tegmina purplish brown, sprinkled with small, paler spots, apical area pale hyaline; large species..... ..... *mucronicollis* (Motsch.)

2(1) Apex of posterior process reaching the posterior angle of the inner margin of the tegmina.

3(4) Frontoclypeus extending well below the lower margins of vertex; pronotum light brown, with a strong basal ridge projecting forward, a broader less elevated ridge on either ride; metopidium with two broad nearly oval ridges one on either side of the median carina; tegmina greyish white, with a broad transverse brownish ochraceous fascia at about its middle.....*paludatus* Dist.

4(3) Frontoclypeus extending only slightly below the lower margins of vertex; pronotum rusty brown; metopidium with a median and a pair of lateral greyish white streaks; tegmina with a rusty brown transverse facia on its distal half ..... *tuberculatus* (Motsch).

Acknowledgements: Our sincere thanks are due to Mr. A. L. CAPENER for his sustained help and interest in our studies. The first author is also thankful to Dr. W. J. KNIGHT, Dept. of Entomology, British Museum (Natural History), for his kindness to examine the tegminal characters of some of the types in the British Museum, on our behalf, and to the Indian Council of Agricultural Research, New Delhi, for the grant-in-aid during the tenure of which this work was carried out.

REFERENCES

AHMAD, I., N. A. KHAN & N. YASMEEN (1979) An account of *Coccosterphus* (Membracoidea: Centrotinae) from Bangladesh. *Oriental Ins.*, **13** (1—2), 219—217.

ANANTHASUBRAMANIAN, K. S. & T. N. ANANTHAKRISHNAN (1975) Taxonomic, biological and ecological studies of some Indian membracids (Insecta : Homoptera) Part I & II. *Rec. Zool. Surv. India*, **68**, 254—2o8, 305—340.

CAPENER, A. L. (1968) Taxonomy of the African Membracidae. Part II. Centrotinae. *Repub. S. Afr. agr. tech. Serv. Ent. Mem*, **17**, 1—123.

DISTANT, W. L. (1908) Rhynchota-Homoptera. The Fauna of British India including Ceylon and Burma. **4**, 70—73.

DISTANT, W. L. (1916) Rhynchota-Homoptera. The Fauna of British India including Ceylon and Burma. **6**, 175—176.

FABRICIUS, J. C. (1803) Rhyngota. Systema Rhyngotorum secundum ordines, genere, species, adiectis synoymis, locis, observationibus, descriptionibus. pp. 1—304.

FUNKHOUTER, (1913) Entomological investigations on the spike disease of sandal. (3) Membracidae (Homoptera). *Indian Forest Rec.*, **17** (10), 1—10.

GODING, F. W. (1934) The Old World Membracidae. *N. Y. Ent. Soc. Jour. J.* **37**, 183—192.

DEMOTSCHULSRY, V. I. (1863) Essai d 'un catalogue des insectes de 1811e Ceylan. *Soc. Nat. Moscou Bul.*, **36**, 1—153.

STAL, C. (1869) Hemiptera Fabriciana. Fabricianska Hemipterarter, efter de i Ropenhamn och Riel forvarade typeexemplaren granskade och beskrifue. 2. Svensk. *Akad Handl.*, **8** (1), 1—130.

Entomon, 1987, *Vol.* **12**, *No.* 3, *pp.* 345 *to* 348

EFFECT OF CERTAIN DILLAPIOLE DERIVATIVES ON RICE STEM BORER, *SCIRPOPHAGA INCERTULAS* (WALKER) EGGS

P. S. P. V. VIDYASAGAR[1]* & SURESH WALIA[2]

[1]Division of Entomology, Central Rice Research Institute, Cuttack, India 753 006
[2]Division of Agricultural Chemistry, I A R I., New Delhi, India 110 012

(Received 21 February 1986)

Different doses of ten dillapiole derivatives were topically applied to rice stem borer egg masses of different age groups (15 h, 40 h, 65 h and 85 h). Out of these ten compounds, heptanoyl dihydrodillapiole, dillapiole methyl ether and dillapiolyl dichlorophenyl cyclopropane @ 0.1 *ml*/ egg mass completely inhibited hatching. Moreover, these compounds were effective even against older egg masses. Hatching in the remaining compounds was comparable to controls.

(*Key words:* yellow stem borer, eggs, hatching inhibition, dillapiole derivatives)

INTRODUCTION

The yellow stem borer, *Scirpophaga incertulas* (Walker), is a serious pest of rice, both at vegetative and heading stages. Several insecticides are available for the control of this pest (SUBRAMANIAN *et al.*, 1981; RAJENDRAN & CHELLAIAH, 1983). Almost all the insecticides marketed are larvicidal and / or adulticidal but not ovicidal. The effectiveness of these pesticides is severely hampered, since the larvae remain mostly inside the stem. It will be of greater significance, if some compounds with ovicidal activity are identified.

Dillapiole, one of the major constituents (27%) of Indian dill, *Anethum sowa* Roxb. seed oil and many of its derivatives have been reported to possess synergistic activity (TOMAR *et al.*, 1978; MUKHERJEE *et al.*, 1982; WALIA *et al.*, 1984). So far none of its derivatives was tested on yellow stem borer for larvicidal or ovicidal properties. The potential contribution of dillapiole derivatives as ovicides in pest management systems has been largely ignored. Moreover, the cyclopropane compounds are known to act as juvenile hormone analogues, which also inhibit egg hatch Therefore, some dillapiole compounds were evaluated in the laboratory for ovicidal action against yellow stem borer.

MATERIAL AND METHODS

Field collected, mated female moths were released separately in glass chimneys with potted rice plants or in glass tubes (2.5×7.5cm) provided with a rice leaf rolled in wet cotton at one end. Every morning egg masses laid on the leaves were collected and were regarded as having a similar age. Most of the oviposition was completed by mid-night and day one of the incubation period started at mid-night on the night of oviposition. Most of the egg masses contained about 40 eggs each though masses with 50 were not uncommon. However, towards the end of oviposition period the size of egg masses reduced drastically and such masses were discarded. After determining the age, egg masses were kept separately in glass vials (5× 1 cm) stoppered with cotton. The egg masses

* Present address: Central Plantation Crops Research Institute, Regional Station, Vittal 574 243.

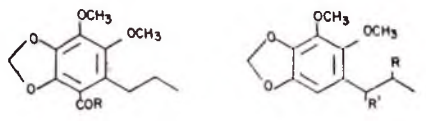
(15 h, 40 h, 65 h and 85 h) were topically treated with the test compounds with the help of corning lambda pipette or Hamilton microsyringe

All compounds tested were pure and were serially diluted in acetone. About 10—20μl acetone containing known quantity of test chemical was applied topically to each egg mass. Acetone treated and/or untreated controls were maintained. The experiments were repeated several times with a minimum of three replications. All effective doses were repeated at least three times with three replications. The test compounds used in this study were synthesized by literature procedures (MUKERJEE *et al.*, 1982; WALIA *et al.*, 1984).

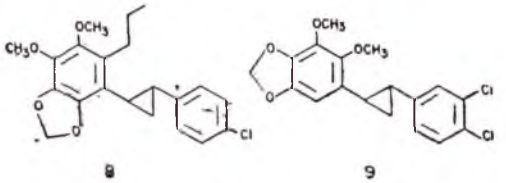
Treated and control egg masses were observed daily for hatching. In cases where no hatching of treated egg masses occurred even after two days of hatching in control, the treated eggs were dissected and approximate degree of development was recorded.

RESULTS AND DISCUSSION

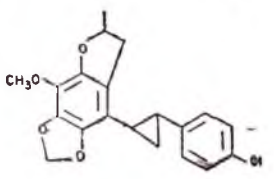
The efficacy of 10 different dillapiole compounds (Fig. 1) against yellow stem borer egg masses of different age groups is given in Table 1. Out of ten dillapiole



1. R = $-CH_3$
2. R = $-C_6H_{13}$
3. R = $-C_8H_{17}$
4. R = $-CH=CH-(CH_2)_6CH_3$
5. R = OCH_3, R' = H
6. R = R' = OAC
7. R = $-OCOC_8H_{17}$, R' = H



8 9



derivatives only three compounds viz. dillapiole methyl ether([5]), heptanoyl dihydrodillapiole([7]) and dillapiolyl dichlorophenyl cyclopropane([9]) inhibited egg hatch, when topically applied @ 0.1 μl/egg mass.

Several chemicals were reported to act as ovicides against many pest species (BEAMENT & LAL, 1957; MITRI & KAMEL, 1970; CHALFANT *et al.*, 1979; PITTS & PIETERS, 1980). The ovicidal properties of certain juvenile hormone analogues were also well established (RIDDIFORD, 1970; SIVASUBRAMANIAN, 1979; FARAGALLA *et al.*, 1980). However, very little information is available on the ovicides of yellow stem borer.

CHALFANT *et al.* (1979) tested 23 insecticides and fungicides in the laboratory for ovicidal activity against two indigenous strains of cabbage looper, *Trichoplusia ni* (Hubner) and found Pydrin, Permethrin, methenyl chlordimeform and U C 51762 as good ovicides. They also noted that field strain was more tolerant to the ovicides than the laboratory strain. Possible explanations include inbreeding of the laboratory strain which could sort out susceptible genotypes and stress induced by adverse laboratory conditions or deficiencies in the diet. According to SMITH & SALKELD (1966) differences in susceptibility of two egg strains or species are due to differential rates of uptake and detoxification, failure of the toxicant to reach the target and also differences in susceptibility of the target to the inhibitor. Since the present investigation is carried out on the egg masses of field population, the results should hold good even against the laboratory reared insects. Further more, SMITH & SALKELD (1966) stated that for any insecticide to be effective as ovicide in the field, eggs must be covered by the spray

TABLE 1. Effect of dillapiole derivatives on egg hatch of *S. incertulas*.

Expt. no.	treatment	dosage (µl/ egg mass	age (hours)	hatching
1.	Acetyl dihydrodillapiole	0.2	15	normal
		0.5	40	normal
2.	Heptanoyl dihydrodillapiole	0.05	15	normal
		0.05	40	normal
		0.05	65	normal
		0.1	15	nil
		0.1	40	nil
		0.1	65	nil
		0.1	85	nil
		0.2	15	nil
		0.2	40	nil
		0 2	65	nil
		0.2	85	nil
3.	Pelargonyl dihydrodillapiole	0.05	15	normal
		0.1	15	normal
		0.1	40	normal
4.	Nonenoyl dihydrodillapiole	0.2	15	normal
		0.5	15	normal
5.	Dillapiole methyl ether	0.05	15	normal
		0.05	65	normal
		0.1	15	nil
		0.1	40	nil
		0.2	15	nil
		0.2	40	nil
		0.2	85	nil
		0.5	15	nil
		0.5	40	nil
		0.5	65	nil
6.	Dillapiole acetate	0.5	15	normal
		0.5	40	normal
7.	Dillapiole nonanoate	0.05	15	normal
		0.1	15	normal
		0.2	15	normal
		0.5	15	normal
8.	Dihydrodillapiole	0.05	15	normal
	Chlorophenyl Cyclopropane	0.1	15	normal
		0.2	15	normal
		0.2	40	normal
		0.2	85	normal
9.	Dillapiolyl dichlorophenyl	0.1	15	nil
	cyclopropane	0 5	15	nil
		0.5	40	nil
10.	Furapiolyl chlorophenyl	0.2	15	normal
	cyclopropane	0.5	15	normal
	Control		15	normal
	(Acetone)		40	normal
			65	normal
			85	normal

material, as the data indicates little or no fumigant activity. This point is to be considered carefully because the site of oviposition differs in different species. In *S. incertulas* eggs are laid on rice leaf blades and are always exposed. Any spray formulation can effectively cover the entire egg mass surface provided it penetrates the thick hairy covering of egg mass. In the present study chemicals in acetone readily penetrated these hairs and reached the target areas of the embryo.

Another factor for the success of an ovicide is that sufficient proportion of the population must be in the egg stage when treated. Though this condition may not be met with in many other species, in the present species majority of the population reaches the egg stage at a time.

When 40 h egg masses of *S. incertulas* are treated with dillapiole methyl ether @ 0.1 μl/egg mass, the development continued and the larvae died shortly before eclosion. This is revealed by the dissections of treated eggs after the hatching occurred in controls. However, if the treatments are made at 15 h stage there is very slight development of the embryo. It thus appears that the toxic dose of dillapiole methyl ether passes through the chorion much quickly in the latter, whereas it is absorbed by embryo at some stage prior to hatch in the former.

It is concluded that the chemicals identified as ovicides in the present study hold high promise in view of the economic importance of the pest.

Acknowledgements : The authors wish to thank Dr. H. K. Pande, Director, Central Rice Research institute, for encouragement and research facilities and Shri. J. P. Kulshreshtha, Head of Entomology Division for keen interest in the work.

REFERENCES

Chalfant, R. B., J. W. Todd, & E. Mullinix (1979) Cabbage looper : Ovicidal activity of pesticides in the laboratory. *J. econ. Ent.*, **72**, 30—32.

Faragalla, A. A., Berry, C. E. & W. D. Guthrie (1980) Ovicidal activity of diflubenzuron on European corn borer egg masses. *J. econ. Ent.*, **73**, 573—574.

Mitri, S. H. & A. A. Kamel (1970) Ovicidal effects of certain newer insecticides on *Spodoptera littoralis* egg masses. *J. econ. Ent.*, **63**, 676—678.

Mukerjee,, S. K., S. Walia, V. S. Saxena & S. S. Tomar (1982) New pyrethrum synergists from dihydrodillapiole and furapiole. *Agric. biol. Chem*, **46**, 1277—1283.

Pitts,D. L. & Pieters, E. P. (1980) Ovicidal activity of insecticides against tobacco budworm eggs on cotton. *J. econ. Ent*, **73**, 570—572.

Rajendran, B. & S. Chellaiah (1983) Chemical control of rice stem borer and whorl maggot. *Indian J. agric. Sci.*, **53** (3), 183—184.

Riddiford, L. M. (1970) Prevention of metamorphosis by exposure of insect eggs to juvenile hormone analogues. *Science.*, **164**, 287—288.

Sivasubramanian, P. (1979) The ovicidal effects of a juvenile hormone and a juvenile hormone analogue on the flesh fly, *Sarcophaga bullata*. *Ent. exp. appl.*, **25**, 165—171.

Smith, E H. & E. H. Salkeld (1966) The use and action of ovicides. *A. R. Ent.*, **11**, 331—368.

Subramanian, R., G. R. K. Murthy, P. V. Sarma (1981) Control of paddy stem borer, *Tryporyza incertulas* Wlk. with phenyl carbamate insecticides. *Pestology*, **5**, 22—24.

Tomar, S. S., V. S. Saxena, M. L. Maheswari, Prakash Sarup & S. K. Mukerjee (1978) New carbaryl synergists derived from dillapiole. *Indian J. ent*, **40**(2), 113—116.

Walia, S., V. S. Saxena & S. K. Mukerjee (1984) Cyclopropyl MDP compounds as new pyrethrum synergists. *Agric. biol. Chem*, **48**(11), 2675—2679.

Entomon, 1987, *Vol.* **12**, *No.* 4, *pp.* 349 *to* 356

TWO NEW SPECIES OF *SYZEUCTUS* FOERSTER (HYMENOPTERA : ICHNEUMONIDAE) FROM INDIA

P. K. NIKAM & L. J. KANHEKAR[1]

Entomology Research Laboratory, Department of Zoology, Marathwada University, Aurangabad, India 431 004

(Received 7 March 1986)

Two new species of the genus *Syzeuctus* Foerster *viz*, *S. indicus* and *S nagzirae* from Maharashtra, India are described and illustrated.

(Key words : New species of *Syzeuctus*, Maharashtra)

Syzeuctus Foerster (1868) is a large genus of world wide distribution (Ichneumonidae : Banchinae). Townes *et al.*, (1961) included seven species under this genus from Indo-Australian region. Chandra and Gupta (1977) included ten species of this genus from the Orient, provided a well defined key to the species divided the species into three species groups *viz*, (i) the *villosus*, (ii) the *zanthorious* and (iii) the *claripennis* group. This work has been followed here and two new species *viz.*, *Syzeuctus indicus* and *S. nagzirae* of *zanthorius* group are described and illustrated.

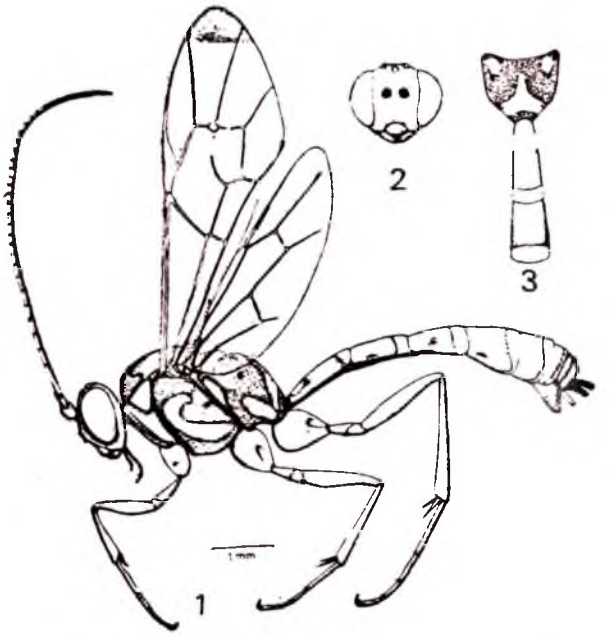
The type material of these species are with the authors for the time being and will be deposited in Zoological Survey of India, Calcutta.

1. Syzeuctus indicus sp. nov. (Figs. 1-3)

Female: Body (Fig. 1) 7.3-9.0 mm. Head (Fig. 2) 0.85 as long as broad, pubescent; vertex sparsely, weakly punctate; interocellar distance 2 times the ocello-ocular; frons medially concave, moderately punctate, above antennal socket smooth; flagellum 34-36 segmented, 1st flagellar segment 2 times the length of 2nd face 0.60-0.65 as long as broad, weakly convex, moderately punctate; clypeus 0.5 as long as broad, finely, sparsely punctate; cheek 0.6—0.8 the basal width of mandible; mandibular teeth subequal; temple and hind portion of vertex sparsely, finely, weakly punctate; occipital carina complete.

Thorax pubescent, widely moderately punctate, 1.95-2.25 times as long as broad; pronotum moderately punctate except smooth antero-ventrally, obliquely, moderately depressed, epomia strong, collar smooth; mesoscutum moderately spaced, widely punctate, notauli absent; scutellum convex, moderately, widely, punctate, lateral carinae restricted to base; postscutellum weakly punctate; propodeum (Fig. 3) deeply more widely, densely punctate apical transverse carina present apico-laterally, medially absent, pleural carina absent, spiracles elliptical; propleurum sparsely punctate; mesopleurum moderately spaced, widely punctate, medio-posteriorly

[1]Present Adderss : Department of Zoology, Modern College of Arts, Science and Commerce, Pune, India 411 005.



Syzeuctus indicus, sp. nov. (Figs. 1—3). 1. Adult female laterel view; 2. Head viewed from front; 3. Propodeum with 1st and 2nd tergites.

obliquely depressed, smooth; speculum moderately punctate, sternaulus absent, prepectal carina distinct, reaching above the lower hind margin of pronotum; metapleurum moderately punctate; hind femur 5.45–6 times as long as its median depth, tibia 7.85—8.30 times as long as its apical width, tarsal claw curved, pectinate basally. Fore wing 4.95—6.20 mm long, 1.55–2 mm broad; 1st radial abscissa 0.50–0.55 the length of its apical abscissa; petiole 0.85–0.90 the height of areolet, latter receiving 2nd recurrent distad to its middle; nervulus distad by 0.10—0.25 its length, 0.50–0.55 the length of postnervulus; basal abscissa of postnervulus 1.10—1.25 times the length of its apical abscissa; 2nd discoidal cell 2.05—2.10 times as long as broad; discocubital cell 2.05—2.15 times as long as broad; hind wing 3.75—4.50 mm long, 1.10—1.40 mm broad with 1+8 hamuli; 1st abscissa of radiella 0.40—0.45 the length of its apical abscissa; superior and inferior nervellar abscissae in the ratio of 7 : 3; discoidella weakly traceable; brachiella short, pigmented, not joining apical margin of wing.

Abdomen 1.50—1.65 times as long as the length of head and thorax combined: 1st tergite (Fig. 3) weekly narrowed towards base, weakly, sparsely punctate, apically smooth, 2.5—2.8 times as long as its apical width, 1.45—1.55 times as long as 2nd tergite, median dorsal and dorso-lateral carinae absent; 2nd tergite weakly, sparsely punctate, 1.5 times as long as its apical width; punctures on 3rd and 4th tergites small, sparse; rest of

the tergites minutely, sparsely punctate; subgenital plate weakly, minutely punctate; ovipositor long, cylindrical, curved, shorter than abdomen; ovipositor sheath 0.7—0.9 the length of fore wing, 2.0—2.2 times as long as hind tibia.

Black. Yellow portions are : face except median longitudinal band, clypeus, mandibles except teeth, cheek, palpi, front margin of temple continuously with the lateral margin of vertex, frons laterally, scape apically, collar, pronotum with subtriangular mark at dorso-posterior region, antero-lateral triangular portion confluent with a narrow band to medio-posterior portion of mesoscutum, scutellum laterally and apically, postscutellum, tegulae, subtegular ridge, mesopleurum with a single oblique curved mark, propleurum postero-ventrally, mesosternum antero-medially, upper division and apical half of lower division of metapleurum, inverted 'Y' shaped apical portion of propodeum, a small spot near propodeal spiracles fore and mid trochanters, coxae except antero-basally, femora laterally, hind coxae dorso-posteriorly, 1st tergite with two lateral spots behind 0.12, tergites 1—3 apically, 4—5 tergites apico-medially and apico-laterally with narrow tinge, rest of the tergites with apical tinge; subgenital plate apico-medially blackish, rest yellow; fore wings clouded apically; hind femora except medially, and tibiae yellowish-brown; ovipositor reddish; flagellum reddish-brown.

Male : Agrees with the female in all characters except : thorax 2.5 times as long as broad, 1st tergite 3 times as long as broad, hind wing with 1+6 hamuli; face, clypeus, front side of scape and pedicel, all tergites apically, genitalia, yellow; dorso-posterior yellow portion of pronotum broadly confluent with the longitudinal anterior mark and mesopleural portion confluent with mesosternal portion with a weak band.

Variations : The yellow portion of head may be reddish-brown to reddish-yellow, 2nd tergite with a small baso-lateral yellow spot, 5th tergite apico-medially yellow, rest of the tergites reddish.

Holotype : ♀, INDIA : MAHARASHTRA, Nashik, Deolali Camp, 29.ix.1984, Malaise Trap Coll. Wings, antenna and legs mounted on slides and labelled as above.

Allotype : ♂, data same as Holotype except : i.x.1984, on wing, S. M. Nikam Coll.

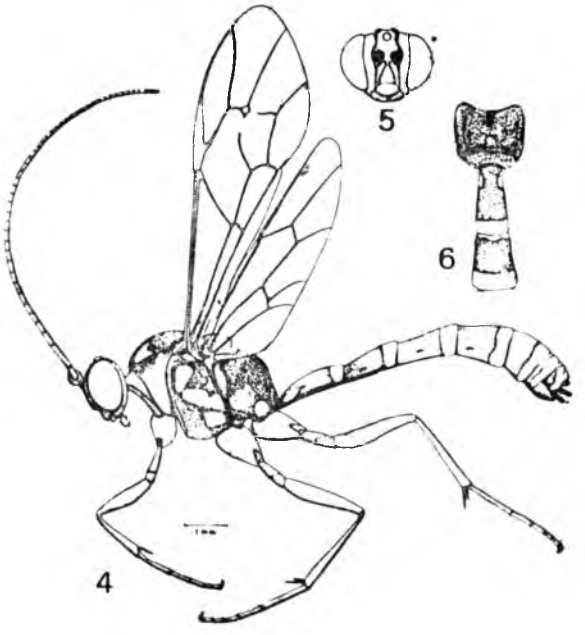
Paratypes: 4♀♀, INDIA : MAHARASHTRA, Aurangabad, Marathwada University Botanical Garden, 1 ♀, 11.xi.1982: 1 ♀, 22.xii. 1982, Malaise Trap Coll. Wings, antennae and legs mounted on slides and labelled as above: 1 ♀, (Donated to H. Townes U S A) data same as holotype; 1♀, data same as allotype.

Remarks : In accordance with the key to the Oriental species of *Syzeuctus* by Chandra and Gupta (1977) this species fits in the *zanthorius* group and resembles *S. torrevillasi* Momi in the characters as per the key. However, it differs from the same in having : cheek 0.6—0.8 the basal width of mandible; mesopleurum medio-posteriorly obliquely smooth; propodeum widely, densely, deeply punctate; apical transverse carina of propodeum only at apical corners; wing clouded apically; nervulus distad to basal vein: tarsal claws pectinate basally; 1st tergite with lateral yellow spots behind 0.12 and hind femora medially blackish-brown.

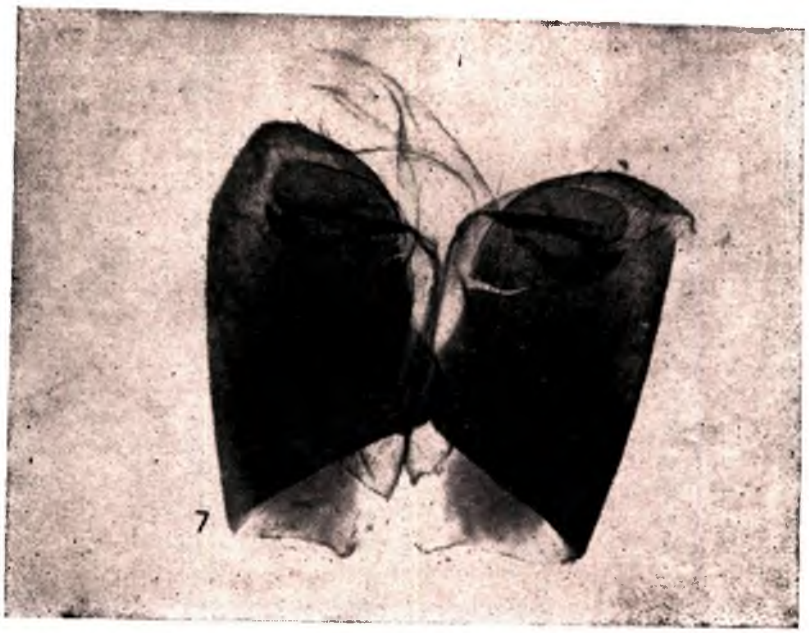
2. Syzeuctus nagzirae, sp. nov. (Figs. 4–6, 7—8)

Female: Body (Fig. 4) 11.35—11.55 mm. Head (Fig. 5) 0.75 as long as broad; vertex sparsely, finely punctate; ocellar triangle weakly raised; inter-ocellar distace 1.15 times the ocello-ocular disance; frons medially grooved, smooth, laterally moderately punctate, above antennal sockets weakly grooved, smooth; flagellum 44—48 segmented; first flagellar segment 2 times as long as the length of 2nd; face 0.65 as long as broad, convex, moderately punctate, laterads to antennal sockets to clypeo-facial suture with weak groove; clypeus 0.65 as long as broad, finely punctate, convex; cheek 0.55 the length of basal width of mandible, weakly mat; mandibular teeth unequal; temple and hind portion of vertex sparsely, finely punctate, with long sparse thin hairs; occipital carina complete.

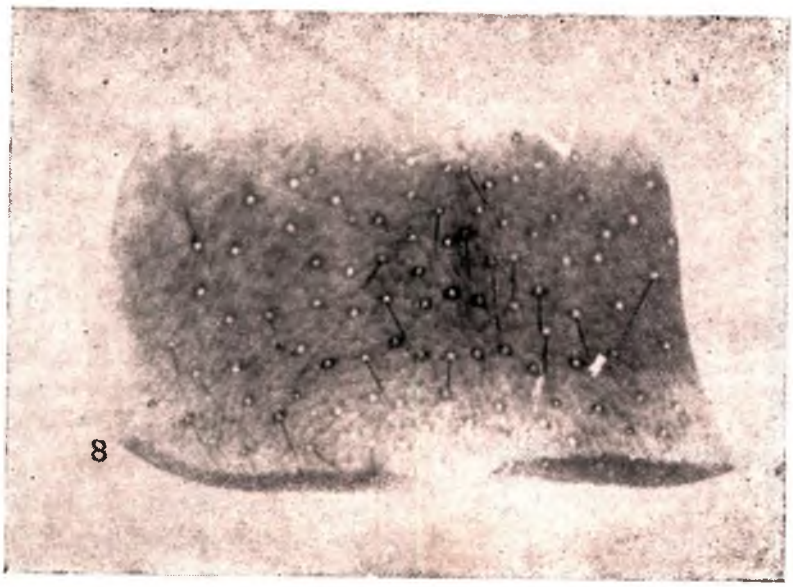
Thorax pubescent with moderate, wide, dense punctures, 2.2 times as long as broad; pronotum densely punctate, behind epomia and ventrally smooth obliquely depressed, epomia strong, collar weakly punctate; mesoscutum densely, widely punctate, notauli absent; scutellum convex, widely, densely punctate, lateral carinae restricted at base; postscutellum smooth, shiny; propodeum (Fig. 6) more widely, densely punctate, baso-medially weakly grooved,apical transvese and pleural carinae distinct, entire, spiracles elongate; propleurum sparsely punctate; mesopleurum widely, densely punctate, medio-posteriorly obliquely deppressed, smooth, speculum



Syzeuctus nagzirae, sp. nov. (Figs. 4—6). 4. Adult female lateral view; 5. Head viewed from front; 6. Propodeum with 1st and 2nd tergites.



Figs. 7—8 *Syzeuctus nagzirae*, sp. nov. 7. Male genitalia;



8. Subgenital plate.

punctate, sternaulus absent; prepectal carina short and strong, reaching above the lower hind margin of pronotum; metapleurum widely, densely punctate; hind femur 5.3—5.6 times as long as its median depth, tibia 8.9—9.0 times as long as its apical width, claw curved, basally pectinate. Fore wing 8.0—8.2mm long 3.0—3.2 mm broad; first radial abscissa 0.6 the length of its apical abscissa; petiole as long as height of areolet, latter receiving 2nd recurrent distad of its middle; nervulus distad to basal vein by 0.2 its length, 0.35 the length of postnervulus; basal abscissa of postnervulus 1.65 times the length of its apical abscissa; 2nd recurrent slightly inclivous, 0.5 the length of basal abscissa of subdiscoideus; latter 1.05 times the length of its apical abscissa; 2nd discoidal cell 1.85 times as long as broad; discocubital cell 2.2 times as long as broad; hind wing 5.8—6.0 mm long, 1.5—1.65 mm broad, with 1 + 8 hamuli; 1st abscissa of radiella 0.45 the length of its apical abscissa; superior and inferior nervellar abscissae in the ratio of 11 : 6; discoidella and brachiella pigmented; latter long, not joining the apical margin of wing.

Abdomen 1.8 times as long as head and thorax combined; 1st tergite (Fig. 6) weakly narrowed towards the base, 2.25 times as long as its apical width, 1.35 times as long as 2nd tergite with short dorso-lateral carinae at base, moderately punctate, dorso-medially narrowly and apically smooth and shiny; 2nd tergite 1.35 times as long as its apical width, moderately, densely punctate, punctures sparse apically, extreme apical margin smooth, shiny; punctures on 3rd and 4th tergites dense, small; rest of the tergites shagreened except last impunctate; ovipositor cylindrical, straight, longer than the abdomen; ovipositor sheath equal to the length of fore wing, 2.4 times as long as the hind tibia; subgenital plate weakly, sparsely punctate.

Black, yellowish-white markings are: face except longitudinally in the middle and below antennal sockets, clypeus except apical margin, mandible except apex, cheek, front margin of temple continuously with lateral margins of vertex and frons, collar, pronotum with small spot dorso-medially opposite to triangular mark of mesoscutum, baso-laterally triangular and postero-median mark on mesoscutum, scutellum baso-laterally and apico-transversly, postscutellum, tegulae, subtegular ridge, mesopleurum antero-medially and postero-basally, upper half of the upper division and apical part of lower division of metapleurum, along the apical side of apical transverse carina, a strip from mid propodeum to apical transverse carina, small spot above the propodeal spiracles, fore coxae and trochanters, hind coxae with apico-posterior spot, lateral spots at 0.15 to 0.35 on 1st tergite and apical margin of 1st—7th tergites, 2nd—5th tergites narrowly tinged, subgenital plate apically; fore legs yellowish-red except coxae and trochanters, mid legs yellowish-red except coxae baso-posteriorly; hind legs yellowish-red except coxae basally; apical margin of clypeus, mandible apically except teeth reddish-brown; antennae except scape and pedicel apically, ovipositor sheath, wings blackish-brown; ovipositor reddish; scape and pedicel apically with brownish tinged.

Male : Agrees with the female in all respect except : body 11.75—12.60 mm long, 1st tergite 2.5 times as long as broad apically, hind claw simple, yellowish-white markings slightly broader, lateral markings of scutellum confluent

or not confluent with apical marking, marking of apical transverse carina confluent with lower apical marking of metapleurum; anntennal sockets, face entirely, pronotum dorsally and laterally, mid coxae except postero-basally yellowish-white.

Genitalia : Gonosquammae, volsellae and aedeagus situated on the sclerotic ring (Fig. 7); gonoforceps pubescent, gonosquammae broad, rounded, gonostipes flat, gonocardo rounded; distivolsellae pointed, ventral area of basivolsella flat; aedeagus long, rounded apically, weakly sclerotized; subg nital plate (Fig. 8) rectangular, sparsely punctate, pubescent; anticosta weakly pointed, spiculum moderately triangular.

Holotype : ♀, INDIA : MAHARASHTRA : Nagzira Wild Life Sanctuary (Dist. Bhandara), 3.x.1982, on wing L. J. Kanhekar Coll. Antennae, wings and claws mounted on slides and lebelled as above.

Allotype : ♂, data same as holotype except 29.ix.1982, Malaise Trap Coll.

Paratypes : 1 ♀, 4 ♂♂, data same as holotype except; 1 ♀, 29.ix.1982; 1 ♂, 2.x.1982 (Wings, antennae, claws and genitalia mounted on slides); 1♂, 3.x.1982, on wing, L. J. Kanhekar Col ; 1 ♂, 29.ix.1982, Malaise Trap Coll. (Donated to H. Townes, U S A.); 1 ♂: Anandawalli (Dist. Nashik), 28.viii 1984, on wing, L. J. Kanhekar Coll.

Remarks : In the key to the Oriental species of *Syzeuctus* by Chandra and Gupta (1977) this species fits in the *zanthorius* group and resembles *S. immedicatus* Chandra and Gupta but differs from it in having: clypeus apically punctate; interocellar distance 1.15 times the ocello-ocular: prepectel carina ending above the lower hind corner of pronotun, mesopleurum medioposteriorly obliquely depressed and smooth; spiculum punctate; propodeum baso-medially weakly grooved; forewing not clouded apically; tarsal claw pectinate basally; 1st tergite dorso-medially narrowly smooth and with dorso-lateral carinae short at base.

This species is named after the locality : Nagzira Wild Life Sanctuary, Dist. Bhandara, Maharashtra.

Key to the Oriental species of *zanthorius* Group of *Syzeuctus* Chandra and Gupta (1977) after including new species, *viz.*, *S. indicus* and *S. nagzirae* will be as follows:

6. Apical transverse carina of propodeum absent, represented by an obtuse ridge or present at apical corner of propodeum 7

— Apical transverse carina of propodeum complete 8

7. Upper half of mesopleurum and dorso-median portion of propodeum unsculptured: cheek equal to the basal width of mandible; face densely, coarsely punctate; fore wing not clouded apically; nervulus opposite to basal vein; hind femora reddish-brown; tarsal claw simple; 1st tergite basally black. Philippines..... ....*torrevillasi* Momoi 1971

— Mesopleurum medio-posteriorly obliquely depressed and smooth; propodeum widely, densely punctate; cheek 0.6—0 80 the basal width of mandible; face moderately punctate; fore wing clouded apically; nervulus slightly distad to basal vein; hind femora medially blackish-brown tarsal claws basally pectinate; 1st tergite laterally with two yellow spots behind 0.12 India..... .....*indicus* sp. nov.

8. Ovipositors shorter than the abdomen, claw simple. Java.....*incompletus* Szepligeti, 1908

— Ovipositor distinctly longer than abdomen; claw pectinate except in ♂ of *nagzirae*. sp. nov..... 9

9. Propodeum with distinct pleural carina; tergites 2—3 black in the middle, red or yellowish-brown basally, apically yellow with reddish or brownish, tinge flagllum 44—48 segmented 10

— Propodeum without pleural carina tergites 2-3 black, apically yellow; flagellum 27-41 segmented 11

10. Clypeus apically smooth; prepectal carina ending near the lower hind corner of pronotum; speculum smooth; propodeum without groove baso-medially; fore wing apically clouded in ♀; base and apex of 1st tergite yellow. Burma, India..... .....*immedicatus* Chandra & Gupta, 1977

— Clypeus finely punctate; prepectal carina ending above the lower hind corner of pronotum; speculum punctate; propodeum with a weak groove baso-medially; fore wing not clouded appically; 1st tergite latero-subbasally and apically yellowish-white. India.....*nagzirae*, sp. nov.

11. Ovipositor sheath 2.6—2 8 times as long as hind tibia; tergites of ♀ except the 1st strongly. densely punctate; hind coxae basally and trochanters black; apical margins of all tergites yellow. Burma, India.....*zanthorius* Cameron, 1902

— Ovipositor sheath 4 times as long as hind tibia; all tergites smooth and shiny with minute punctures; hind coxae and trochanters entirely orange-red; tergites 6-8 without yellow apical margins. India..... .....*leptopunctatus* Chandra & Gupta, 1977

Acknowledgements The authors are grateful to Prof. R. NAGABHUSHANAM, Head, Department of Zoology, Marathwada University, Aurangabad for providing laboratory facilities and to C S I R., New Delhi for award of a Senior Research Fellowship to the Junior author. Thanks are also due to Dr H. TOWNES, Amerıean Entomological Institute, 3005 SW 56th Avenue, Gainesville, Florida 32608, U S A for confirming the identifications. The help rendered by Dr. H. G. GHATE is gratefully acknowledged.

REFERENCES

CAMERON, P. (1902) Description of new genera and species of Hymenoptera collected by major C. G. Nurse at Deesa, Simla and Ferozepore. *J. Bombay nat. Hist. Soc.*, **14**, 419—449.

CHANDRA, G. & V. K. GUPTA (1977) Ichneumonologia Orientalis Part—VII. The tribe Lissonotini and Bachini (Hymenoptera: Ichneumonidae:Banchinae). *Oriental Ins. Monogr.*, 7, 1—290.

FOERSTER, A. (1868) Synopsis der Familien und Gattungen der Ichneumonen. *Verh. naturh. Ver. preuss. Rheini* , **25**, 135—221.

MOMOI, S. (1971) Some Ephialtinae, Xoridinae and Bachinae of the Philippines. *Pacief. Insects*, **13**(1), 123—139.

SZEPLIGETI, G. V. (1908) E. Jacobson'sche Hymenopteran aus Semarang (Java). Evaniden Braconiden und Ichneumoniden. *Notes Leyden Mus* , **29**, 209—261.

TOWNES, H., M. TOWNES & V. K. GUPTA (1961) A catalogue and reclassification of the Indo-Australian Ichneumonidae. *Mem. Amer. Ent. Inst.*, **1**, 1—522.

Entomon, 1987, *Vol.* **12**, *No.* **4**, *pp.* 357 *to* 362

LIFE-TABLES AND INTRINSIC RATE OF NATURAL INCREASE OF *GORYPHUS NURSEI* (ACMERON) (HYMENOPTERA : ICHNEUMONIDAE) POPULATION ON *EARIAS VITTELLA* PUPAE

P. K. NIKAM, L. J. KANHEKAR[1] & C. D. BASARKAR[2]

Department of Zoology, Marathwada University, Aurangabad, India 431 004

(Received 28 April 1986)

The life-tables and intrinsic rate of increase of *Goryphus nursei* (Cameron), a pupal parasitoid of cotton bollworm, *Earias vittella* Stoll (Lepidoptera : Arctiidae) were determined in the present work. The intrinsic rate of increase was 0.136 per female per day, and population multiplied 30.36 times in the cohort generation time of 27.68 days.

(Key words : life tables, intrinsic rate of increase, *Goryphus nursei*, *Earias vittella*)

INTRODUCTION

The species of this genus are parasitoids of various lepidopterous and coleopterous pests of important crops. The biology of *Goryphus nursei* (Cameron) was studied by BEESON & CHATTERJEE (1935), AHMED & GHULAMULLAH (1945), and KHAN & VERMA (1946). JONATHAN & GUPTA (1973) summarised the biology and hosts recorded in taxonomic revision of the *Goryphus*-complex from the Oriental region. BASARKAR & NIKAM (1982) studied the longevity, fecundity and sex ratio of *G. nursei*.

Information on life tables and intrinsic rate of natural increase of *G. nursei* helpful in the utilisation of this species in biocontrol programmes, is not available and is worked out here.

Effectiveness of hymenopterous parasitoids in terms of their intrinsic rates of natural increase has been assessed by MESSENGER (1964), FORCE (1970), ORPHNIDES & GONZALAZ (1971). CHUNDURWAR (1975, 1977), NIKAM & BASARKAR (1981), NIKAM & SATHE (1983) and SATHE & NIKAM (1984) constructed life tables and determined intrinsic rate of natural increase of hymenopterous parasitoids.

MATERIAL AND METHODS

The longevity, fecundity and sex-ratio of *G. nursei* worked out by BASARKAR & NIKAM (1982) averaged 24.6 days, 82.4 Individuals and 1.62♂: 1♀ in laboratory conditions (22 ± 1° C and 50—55% RH) respectively are taken into account for the present work. The life tables and intrinsic rate of natural increase are worked out by using BIRCH's (1948) formula, as elaborated by HOWE (1953), WATSON (1964) and SOUTHWOOD (1978).

Table 1 expresses the life table statistics from which the increase was determined (Fig. 1) by using the equation :

$$\Sigma\, e^{-r_m X}\, l_x\, m_x = 1,$$

1 Post-Graduate Research Centre, Department of Zoology, Modern College, Pune—411 005.

2 Nimbkar Agricultural Reaearch Institute, Phaltan, Satara—415 523.

where 'e' is the base of the natural logarithms, X is the age of the individuals in days, l_x is the number of individuals alive at age X as the proportion one, and m_x is the number of female offsprings produced per female in the age interval X. The sum of the products $l_x\ m_x$ is the net reproductive rate R_o, the rate of multiplication of population for each generation measured in terms of females produced per generation. The precise value of cohort generation was calculated as follows:

$$T_c = \frac{\Sigma\ l_x\ m_x\ X}{\Sigma\ l_x\ m_x}$$

The arbitrary value of innate capacity for increase r_c was calculated from the equation :

$$r_c = \frac{\text{Log}_e\ R_o}{T_c}$$

This was an approximate value r_m. The values of the negative exponent of $e^{-r_m X}$ ascertained from this experiment often lay outside the range given in the Table. For this reason both the sides of equation were multiplied by a factor of e^7 to give $e^7 \left(e^{-r_m X} l_x\ m_x \right)$ $= e^7$ or $e^{7 - r_m X} l_x\ m_x = 1096.6$. The two values of $\Sigma\ e^{7 - r_m X} l_x\ m_x$ were then plotted on the horizontal axis (Table 2 and Fig. 1) againts their respective arbitrary r_m's on the vertical axis, two points were joined to give a line which intersected a vertical line drawn from the desired value of $e^{7 - r_m X} l_x\ m_x$ (1096.6).

The point of intersection gives the value of r_m accurate to three decimal places. The precise generation time 'T' was then calculated from the equation :

$$T = \frac{\text{Log}_e\ R_o}{r_m}$$

RESULTS AND DISCUSSION

The average period of the immature stages was 17 days in addition to a 1 day preoviposition period. The maximum mean production, m_x was 2.1 on the first day. The intrinsic rate of natural increase was found to be 0.136 per female per day (Fig. 1), and population of *G. nursei* multiplied 30.36 times in the cohort generation time T_c of 27.68 days

$$T_c = \frac{\Sigma\ l_x\ m_x\ X}{\Sigma\ l_x\ m_x} = \frac{839.69}{30.36} = 27.68$$

where T_c is arbitrary T

$$r_c \quad \frac{\text{Log}_e\ R_o}{T_c} = \frac{\text{Log}_e\ 30.36}{27.68} = 0.1234$$

where r_c is an approximate r_m

Now approximate r_m's (r_c's) are 0.10 and 0.14

$e^{-r_m X} l_x\ m_x = 1$,

$r_m = 0.136$ (Fig. 1)

The mean generation time 'T' was calculated as

$$T = \frac{\text{Log}_e\ 30.36}{0.136} = 25.10 \text{ days.}$$

The capacity for increase approximates very closely to the intrinsic rate of natural increase (ANDREWARTHA & BIRCH, 1954; LAUGHLIN, 1965) in the present study. MESSENGER (1964) proved the utility of intrinsic rate of natural increase for use as a bioclimatic index in rating the braconid parasitoid of an aphid. Under laboratory conditions life tables of an

TABLE 1. Life-table statistics of *Goryphus nursei* (1—17 days immature stages (pre-oviposition period 1 day)

Pivotal age (days) X	proportional life at age X l_x	No of female progeny/female m_x	$l_x m_x$	$l_x m_x X$
19	1.00	2.10	2.10	39.90
20	1.00	1.80	1.80	36.00
21	1.00	1.60	1.60	33.60
22	1.00	1.70	1.70	37.40
23	1.00	2.00	2.00	46.00
24	1.00	1.70	1.70	40.80
25	1.00	1.70	1.70	42.50
26	1.00	1.60	1.60	41.60
27	1.00	1.80	1.80	48.60
28	1.00	1.60	1.60	44.80
29	1.00	1.30	1.30	37.70
30	1.00	1.30	1.30	39.00
31	1.00	1.40	1.40	43.40
32	1.00	1.40	1.40	44.80
33	1.00	1.60	1.60	52.80
34	1.00	1.20	1.20	40.80
35	1.00	1.10	1.20	38.50
36	0.90	1.10	0.99	35.64
37	0.90	0.90	0.81	29.97
38	0.90	0.60	0.54	20.52
39	0,80	0.60	0.48	18.72
40	0.80	0.20	0.16	6.40
41	0.70	0.30	0.21	8.61
42	0.70	0.20	0.14	5.88
43	0.50	0.00	0.00	0.00
44	0.50	0.20	0.10	4.40
45	0.30	0.10	0.03	1.35
46	0.20	0.00	0.00	0.00
47	0.20	0.00	0.00	0.00
48	0.10	0.00	0.00	0.00
			Σ 30.36	Σ8 39.69

TABLE 2. Provisional r_m (0.1 0) and (0.14) for *G. nursei* and related values $e^{-r_m X} l_x m_x$

$r_m = 0.10$		$r_m = 0.14$	
$e^{-r_m X}$	$e^{-r_m X} l_x m_x$	$e^{-r_m X}$	$e^{-r_m X} l_x m_x$
164.0219	344.4460	76.7075	161.0858
148.4132	267.1437	66.6863	120.0354
134.2898	214.8636	57.9743	92.7589
121.5104	206.5677	50.4005	85.6808
109.9472	219.8943	43.8160	87.6321
99.4843	169.1233	38.0918	64.7561
90.0171	153.0291	33.1155	56.2963
81.4509	130.3241	28.7892	46.0627
73.6998	132.6598	25.0281	45.0506
66.6863	106.6981	21.7584	34.8134
60.3403	78.4424	18.9158	24.5906
54.5982	70.9776	16.4447	21.3780
49.4025	69.1634	14.2963	20.0148
44.7012	62.5817	12.2963	17.4000
40.4473	64.7157	10.8049	17.2878
36.5982	43.9179	9.3933	11.2720
33.1155	36.4270	8.1662	8.9828
29.9641	29.6645	7.0993	7.0283
27.1126	21.9612	6.1719	4.9992
24.5325	13.2476	5.3656	2.8974
22.1980	10.6550	4.6646	2.2390
20.0855	3.2137	4.0552	0.6488
18.1742	3.8166	3.5254	0.7403
16.4447	2.3023	3.0648	0.4291
14.8797	0.0000	2.6645	0.0000
13.4637	1.3464	2.3164	0.2316
12.1825	0.3655	2.0138	0.0604
	Σ2457.55		Σ934.3721

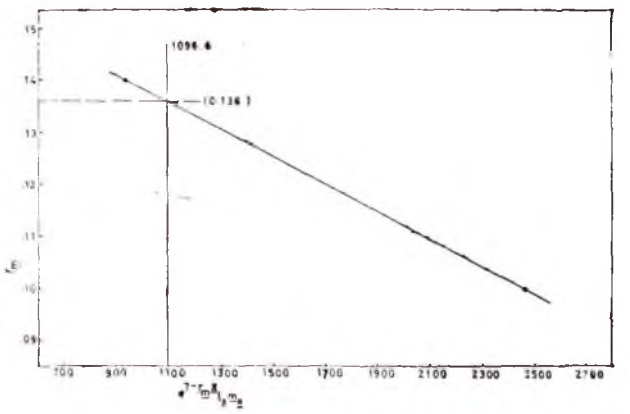


Fig 1. Determination of intrinsic rate of incriare in *Goryphus nursei.*

ichneumonid, *G. nursei*, a parasitoid of cotton bollworm, *E. vittella*, pupae were constructed and the potential use of the former for biological control was studied in terms of effectiveness of its intrinsic rate of natural increase to supress the population of latter. In *Eriborus trochanteratus* (Ichneumonidae) and *Agathis unicolorata* (Braconidae), both parasitoids of *P. operculella* (Zeller), the intrinsic rates of increase were 0.160 and 0.144, the population multiplied 30.56 and 34.56 times in mean generation time of 19.10 and 24.60 days respectively (CHUNDURWAR 1975, 1977). The intrinsic rates of increase were 0.131, 0.176 and 0.188, the population multiplied 43.43, 30.72 and 41.93 times in mean generation times of 28.78, 19.45 and 19.87 days in *Xanthopimpla stemmator* Thunberg (Ichneumonidae), *Cotesia flavipes* (Cameron) and *C. orientalis* Chalikwar & Nikam (Braconidae), the former both pupal and arval parasitoids of *Chilo partellus* (Swin.) and latter larval parasitoid of *Exelastis atomosa* Fab. respectively (NIKAM & BASARKAR, 1981; NIKAM & SATHE, 1983; SATHE & NIKAM, 1984). The possible reason for comparatively low progeny production (82.4 individuals per female) in *G. nursei* is due to its solitary nature (BASARKAR & NIKAM, 1982). In the present study, intrinsic rate of increase (r_m) was 0.136, and population multiplied 30.36 times in the cohort generation time T_c of 27.68 days, which is more biologically meanigful than mean generation time (T) 25.10 days (SLOBODKIN, 1962; LAUGHLIN, 1965; SOOTHWOOD, 1978.

Acknowledgements: The authors are thankful to Prof. R. NAGABHUSHANAM, Head, Department of Zoology, Marathwada University, Aurangrbad, for providing laboratory facilities. Thanks are due to CSIR, New Delhi for awarding a Senior Research Fellowship to LJK.

REFERENCES

AHMED, T. & H. GHULAMULLAH (1945) Ecological studies on the spotted bollworms of cotton and their parasites. *Indian J. Ent.*, 6, 53—59.

ANDREWARTHA, H. G. & L. C. BIRCH (1954) *The distribution and abundance of animals.* University of Chicago Press, Chicago 1—782 pp.

BASARKAR, C. D. & P. K. NIKAM (1982) Longevity, fecundity and sex-ratio of *Goryphus nursei* (Cam.) (Hym , Ichneumonidae), a solitary parasitoid of *Earias vittella* Stoll (Lep., Arctiidae). *Z. ang. Ent.*, **93**, 213—216.

BEESON, C. F. & S. N. CHATTERJEE (1935) On the biology of Ichneumonidae (Hymenoptera). *Indian For. Rec. (N. S.) Ent.*, **1**, 116—168.

BIRCH, L. C. (1948) The intrinsic rate of natural increase in an insect population. *J. Anim. Ecol.*, **17**, 15—26.

CHUNDURWAR, R. D. (1975) Fecundity and life table studies on *Eriborus trochanteratus* Morley (Hymenoptera : Ichneumonidae). *J. Indian Potato Ass.*, **2**, 42—45.

CHUNDURWAR, R. D. (1977) Life table studies and intrinsic rate of increase of *Agathis unicoloratus* (Shenefelt) (Hymenoptera: Braconidae). *Indian Acad. Sci.*, **86**, 39—43.

FORCE, D. C. (1970) Competition among four hymenopterous parasites of endemic insect hosts. *Ann. ent. Soc. Am.*, **63**, 1975—1988.

HOWE, R. W. (1953) The rapid determination of intrinsic rate of an insect population. *Ann appl. Biol.*, **40**, 135—155.

JONATHAN, J. K. & V. K. GUPTA (1973) Ichneumonologia orientalis. Part III. Sub family Mesosteninae. The *Goryphus* complex *Oriental Ins. Mongr.*, **3**, 1—203.

KHAN, M. H. & P. M. VERMA (1946) Studies on *Earias* species (the spotted bollworms of cotton) in Punjab. *Indian J. Ent.*, **7**, 41—63.

LAUGHLIN, R. (1965) Capacity for increase a useful population statistics. *J. Anim. Ecol*, **34**, 77—91.

MESSENGER, P. S. (1954) Use of life tables in a bioclimatic study of an experimental aphid-braconid wasp host-parasite system. *Ecology*, **45**, 119—131.

NIKAM, P. K. & C. D. BASARKAR (1981) Life-tables and intrinsic rate of natural increase of *Xanthopimpla stemmator* Thunberg (Hymenoptera : Ichneumonidae) population on *Chilo partellus* pupae. *Insect Sci. Application*, **2**, 209—213.

NIKAM, P. K. & T. V. SATHE (1983) Life-tables and intrinsic rate of natural increase of *Cotesia flavipes* (Cam.) (Hymen., Braconidae) population on *Chilo partellus* (Swin.) (Lep , Pyralidae). *Z. ang. Ent*, **95**, 171—175.

ORPHANIDES, G. M. & D. GONZALAZ (1971) Fertility and life table studies with *Trichogramma pretiosum* and *T. retorridum* (Hymenoptera : Trichogrammatidae). *Ann. ent. Soc. Am*, **64**, 824—834.

SATHE, T. V. & P. K. NIKAM (1984) Life table and intrinsic rate of natural increase of *Cotesia orientalis* Chalikwar et al. (Hymenoptera, Braconidae), population on *Exelastis atomosa* Fab. *Entomon*, **9**(3), 169—171.

SLOBODKIN, L. B. (1962) *Growth and regulation of animal population* Holt, Rinehart and Winston Inc, New York, 1—184 pp.

SOUTHWOOD, T. R. E. (1978) *Ecological methods: With particular reference to the Study of insect population.* Champman and Hall : London, pp. xxix + 524.

WATSON, T. F. (1964) Influence of host plant condition on population increase of *Tetranychus telerium* (L.) (Acarina : Tetranychidae). *Hilgardia*, **35**, 273—322.

Entomon, 1987, *Vol.* 12, *No.* 4, *pp.* 363 *to* 366

MANAGEMENT OF STEMFLY *OPHIOMYIA PHASEOLI* TRYON ON FRENCH BEANS WITH REDUCED INSECTICIDAL DOSES

P. N. KRISHNA MOORTHY & G. C. TEWARI

Indian Institute of Horticultural Research, Bangalore, India

(Received 2 June 1986)

Economics of management of stemfly, *Ophiomyia phaseoli* Tryon on French beans with minimum insecticidal treatments were worked out. In 1984 trial three commercially available systemic granular insecticides viz , aldicarb, carbofuran and phorate (all at 0.25 and 0.5 kg ai/ha) applied while sowing and foliar sprays of endosulfan (0.7 kg a i/ha) given at 15 and 25 days after sowing were effective in reducing the pest attack. However in 1985 trial the economics of reduced doses of two granular insecticides (phorate and carbofuran) at 0.25 kg a i ha and foliar application of endosulfan 0.7 kg a i/ha given at different days after sowing were compared Phorate application was found to give maximum benefit: cost ratio, followed by endosulfan spray given on 15 days after sowing.

(*Key words*: aldicarb, carbofuran, phorate, endosulfan, dimethoate, phosphamidon monocrotophos, carbaryl, stemfly, *Ophiomyia phaseoli*, French beans)

French beans, *Phaseolus vulgaris* L. is highly suceptible to bean stemfly *Ophiomyia phaseoli* Tryon, which is the most important pest of legumes in Asia, Africa and Australia (SPENCER, 1973). Studies on the biology of this pest have been made (SPENCER, 1973). Eggs of this insect are laid inside the leaf lamina as soon as unifoliate leaves are noticed. The larva mines into the leaves, petioles and stems before pupating at the base of the stem. Fresh pest attack to plants after three weeks of germination do not reduce yield (ANONYMOUS, 1979). Application of systemic granular insecticides (1 or 2 kg a i / ha) while sowing was found to be effective in controlling this pest (JOTWANI & BUTANI, 1977; MOTE, 1983). Foliar sprays done at fortnightly intervals were also effective in controllng this pest (MOTE, 1983).

Application of insecticides at frequent intervals and high doses will not only increase the cost of cultivation but also will be hazardous from residue point of view. Hence, present studies were aimed to develop a suitable strategy for the management of this pest on French beans with reduced application of granular and foliar insecticides.

Two field experiments were undertaken in randomized block design with three replications during summer 1984 (April–May) and rainy season–1985 (August–September). French beans CV "Burpee stringless" was grown during summer, and CV "Arka Komal" during rainy season. Treatments in summer, 1984, included soil application of granular insecticides viz. carbofuran (Furadan 3G), phorate (Thimet 10G) and aldicarb

TABLE 1. Infestation of stemfly *O. phaseoli* on French beans under different treatments (1984).

Treatment	dose (kg ai/ha)	no. of plants infested in 10 plants	
		while flowering (38 DAS)	while harvesting (52 DAS)
carbofuran	0.25	3.00 d	6.33 d
carbofuran	0.5	0.66 b	3.66 ab
phorate	0.25	3.66 e	6.66 d
phorate	0.5	0 a	6.33 d
aldicarb	0.25	5.00 f	8.00 e
aldicarb	0.5	1.66 c	5.00 c
endosulfan	0.7	0.66 b	3.33 a
phosphamidon	0.5	0.33 ab	4.33 abc
monocrotophos	0.5	0.33 ab	4.33 abc
dimethoate	0.5	0.33 ab	4.66 bc
carbaryl	2.0	1.66 c	7.66 de
control	—	8.66 g	9.66 f
C D 5%	—	0.64	1.24

Figures followed by the same alphabet are not significantly different.

(Temik 10G) all at 0.25 and 0.5 kg. a i/ha. Spray of endosulfan (Thiodan 35 EC) at 0.7 kg a i/ha; phosphamidon (Dimecron 1000), monocrotophos (Nuvacron 40 EC) and dimethoate (Rogor 30 EC) all at 0 5 kg a i/ha and carbaryl (Sevin 50 WP) 2 kg a i/ha at 15 and 25 DAS were additional foliar treatments included. Treatments were replicated 3 times along with untreated control. Stemfly incidence was recorded by uprooting and dissecting 10 randomly selected plants in each plot on 38 DAS (after flower and pod formation) and 52 DAS (harvesting time).

In 1985 rainy season, carbofuran and phorate @ 0.25 kg a i/ha were applied to the soil in furrows along with seeds while endosulfan at 0.7 kg a i/ha as foliar spray. Following were the treatments. (i) carbofuran (ii) carbofuran followed by endosulfan on 25 DAS (iii) phorate (iv) phorate followed by endosulfan on 25 DAS (vi) endosulfan on 25 DAS (vii) endosulfan on 15 and 25 DAS (viii) control. Thirty days after sowing, 10 plants were selected at random from each plot for recording the presence or absence of mining (white irregular streaks) by stemfly larva in petioles and stem of the plant. The economics of different treatments were also worked out.

Though application of granular insecticides at 0.5 kg a i/ha gave better control of stemfly as compared to

TABLE 2. Infestation of stemfly, yield and economics of growing French beans under different treatments (1985).

Treatment	petioles-mined/ 10 plants (30 DAS)	stems mined/ 10 plants (30 DAS)	yield kg/ha	cost of insecticide treatment (Rs/ha) (A)	increased return over control (Rs/ha) (B)	benefit cost ratio (B/A)
carbofuran	1.66 bc	1.33 a	11333 bc	193—00	1667—00	8.63
carbofuran + endosulfan (25 DAS)	1.0 a	0 66 a	11733 bc	382—00	2067—00	5.41
phorate	1.33 ab	1.33 a	15267 a	125—00	5601—00	44.80
phorate + endosulfan (25 DAS)	1.66 bc	1.00 a	13867 ba	314—00	4201—00	13.37
endosulfan (15 DAS)	2.00 c	2.00 a	12667 abc	189—00	3001—00	15.87
endosulfan (15 & 25 DAS)	3.00 d	1.00 a	12800 abc	378—00	3131—00	3.29
endosulfan (25 DAS)	3.66 e	2 66 a	11200 bc	189—00	1534—00	8.11
control	9 f	8.66 b	9666 c	—	—	—
C D at 5%	0.48	2.45	3199	—	—	—

Sale price of French beans—Rs. 1/kg of pods.
Cost of carbofuran—Furadan Rs. 21.59/kg and at 0.25 kg ai/ha requires 8.25 kg/ha (Rs. 178—20/ha).
Cost of phorate —Thimet Rs. 44—04/kg and at 0.25 kg ai/ha requires 2.5 kg/ha (Rs. 110—10/ha).
Cost of treatment of granules includes cost of of one labourer/day (Rs. 15/-).
Cost of endosulfan —Thiodan at Rs. 78—50/1. 0.7 kg a i/ha requires 2 1/ha (Rs. 157—00/ha), + spraying requires two labourers (Rs. 30/day/ha) + sprayer hire charges of Rs. 2/- per day.
Figures followed by the same alphabet are statistically at par.

0.25 kg ai/ha the latter was also effective in reducing the pest incidence (Table 1). However, when the pest incidence in 0.25 kg doses of the three granular insecticides was compared, carbofuran and phorate gave significantly better control than aldicarb. Foliar sprays of different insecticides given on 15 and 25 DAS significantly reduced pest incidence (Table 1). This is achieved by the initial control of the pest at unifoliate stage of the crop and additional control ensured by the spray on 25 DAS. This also supports the finding of AMBEKAR *et al.* (1985). Further, endosulfan was found to give sustained control of the pest both on 38 and 52 DAS.

During 1985 rainy season, the pest damage in petioles and stems and different treatment was taken (Table 2). Significant differences among insecticidal treatment were observed only when petiole damages were considered. Nevertheless, when compared with control all the treatments

significantly reduced both petiole and stem damage.

Application of carbofuran followed by endosulfan gave maximum protection against stemfly damage (Table 2), but did not significantly increase yield over control. Phorate application provided effective control of stemfly and registered highest yield and maximum benefit: cost ratio. This treatment was closely followed by endosulfan application at 15 DAS, which also registered higher benefit: cost ratio. Critical scrutiny of the Table further revealed that increased yield need not be due to increased control of the pest. Similar observations were also made by ANONYMOUS (1976). Perhaps a particular level of the pest may induce tillering and increased yield. However, there may be several other factors which are to be investigated further before conclusions can be drawn on the relationship between yield and level of stemfly attack on French beans.

Acknowledgement. Authors thank Sri. M. B. MUNIRATHNAIAH and S. VENKATESHAIAH for the assistance in conducting the studies.

REFERENCES

AMBEKAR, J. S., D. S. POKHARAKAR, D. B. PAWAR, B. D. PATIL & R. N. POKHARKAR (1985) Comparative efficacy of insecticides against stemfly in French beans *J. Maharashtra agric. Uni.*, **10** (3), 300—301.

ANONYMOUS (1976) *Mung Bean Report, 1976*, Asian Vegetable Research and Development Centre, Shanhua, Taiwan, R O C., 72 pp.

ANONYMOUS (1979) *Progress Report for 1978*. Asian Vegetable Research and Development Centre, Shanhua, Taiwan, R O C., 174 pp.

JOTWANI, M. G. & D. K. BUTANI (1977) Insect pests of leguminous vegetables and their control. *Pesticides*, **11** (10), 35—38.

MOTE, U. N. (1983) Seasonal incidence and Chemical control of stemfly in French been and pea. *J. Maharashtra agric. Univ.* **8** (2), 159—161.

SPENCER, K. A. (1973) *Agromyzidae (Diptera) of Economic Importance*. Dr. W. Junk, B. V. The Hague. PP. 418.

Entomon, 1987, *Vol.* **12**, *No.* 4, *pp.* 367 *to* 372

LABORATORY AND FIELD EVALUATIONS OF AN EXOTIC PARASITE, *ALLORHOGAS PYRALOPHAGUS* MARSH (HYMENOPTERA : BRACONIDAE) AGAINST SUGARCANE STALK BORER, *CHILO AURICILIUS* DDGN. (LEPIDOPTERA : PYRALIDAE)

ASHOK VARMA, HEM NIGAM & KISHAN SINGH
Indian Institute of Sugarcane Research, Lucknow, India 226 002

(Received 2 June 1986)

Laboratory and field studies were conducted with *Allorhogas pyralophagus* Marsh, an exotic hymenopterous parasite, against sugarcane stalk borer, *Chilo auricilius* Ddgn. The parasite has accepted five different borer larvae viz , *Chilo auricilius, Chilo partellus* Swinhoe, *Acigona steniellus* Hmpsn., *Chilo sacchariphagus indicus* K. and *Chilo tumidicostalis* Hmpsn , which can be used as laboratory hosts. The parasite has not accepted *Scirpophaga excerptalis* Wlk., *Sesamia inferens* Wlk. and *Corcyra cephalonica* Staint. Technique for mass rearing of the parasite has been perfected using *C. auricilius* and *C. partellus* larvae as laboratory hosts. Field releases of 6,231 adults of *A prayalophgus,* in two crop seasons at the Institute farm resulted in the recovery of the parasite from 'released areas'.

(Key words : Allorhogas pyralophagus, exotic parasite, stalk borer, *Chilo, auricilius)*

INTRODUCTION

Sugarcane stalk borer, *Chilo auricilius* Ddgn., is a major pest of sugarcane in several north Indian states viz., Punjab, Haryana, Uttar Pradesh, Bihar and the north eastern region of Nagaland. In the integrated control of the pest, use of larval parasites during the post-mon soon period was advocated to be feasible owing to the availability of large number of hosts in a suitable stage (mature larvae) in the field until harvest (VARMA & MITRA, 1981).

A number of indigenous larval parasites which have been recorded from the borer (BUTANI, 1972) play a less significant role in the regulation of the pest in nature.

Of the different exotic tachinid parasites which have been introduced into India during the last three decades (RAO *et. al.*, 1971; MOHANRAJ & SAXENA, 1964), only three viz , *Lixophaga diatraea* Tns., *Paratheresia claripalpis* Wulp., and *Sturmiopsis parasitica* Curran have so far been tried against *C. auricilius*. None of the parasites has given encouraging results in becoming established in any of the agroclimatic zones of stalk borer habitat (BINDRA *et. al.*, 1972; KALRA & CHANDRA, 1980; RAO & RAO, 1980; YADAV *et. al.*, 1981).

In October 1982, the nucleus culture of an exotic ectoparasite, *Allorhogas pyralophagus* Marsh was received for trials against sugarcane stalk borer by the Project Co-ordinator, All India Co-ordinnted Research Project on Biological Control of Crop Pests and Weeds,

Bangalore. The parasite has been evaluated for its utility under laborartoy and field conditions and the results are presented in the paper.

MATERIALS AND METHODS

Rearing of the parasite ;

The parasite was reared by the straw pipe technique, developed for rearing small hymenopterous parasites (AVASTHY & TEWARI, 1982), with slight modification. In the present technique a 5 cm piece of cane, trimmed to the diameter of the straw pipe (22. 5 cm long), was inserted into the straw pipe, borer larva sandwitched in between two small cane pieces inside the straw-pipe and open ends were plugged with cotton. The introduction of cane bits restricted the borer movement and wriggling out of the borer larvae from straw pipe during parasitisation.

The rearing cage is made up of plastic jars with small holes on side walls covered with muslin cloth for aeration. The lid of the jar has 20—25 circular holes for fixing of starw pipes (Fig. 1).

Cocoons from which the parasites are likely to emerge out were kept in the jars. The adults were fed on honey solution (50:50 honey and distilled water). Freshly emerged wasps were allowed in the rearing cage for 24 hours for assured mating.

Next day straw pipes with host larvae were inserted through holes of the lid in the rearing jar.

The paralysed larvae *in situ* were cut and stored for the development of cocoons. The unparalysed larvae of the preceding day were again used for the subsequent paralysation. Cocoons, fully formed, were cut open from the straw pipe and kept for emergence of adults.

All the laboratory studies were conducted at temperatures ranging between 25°C—27°C and mean relative humidity ranging between 70—85 per cent.

Rearing of the host :

Stalk borer larvae were reared as per the methods developed by Varma *et al.* (1975). Mature larvae of the borer were removed from the diet and used in all the experiments conducted in the laboratory and for mass production of the parasites for field releases.

Field colonisation :

In the year 1982—1983 crop season, half an acre field, planted in spring with a susceptible variety CoLK 7701 was selected and weekly releases of the parasites were made from October 1982 to March 1983. In the year 1983—1984 crop season also the releases of the parasites was resorted in a field planted with CoLK 7701 during the same period as details in Table 3.

At harvest, cane samples, one hundred in number, were split open from the 'released area'. The sample unit comprised a qudrant (2 × 2 sqm) selected at randomly from all over the field.

Presence of the parasite cocoon or grub feeding on borer larvae was taken as indication for the field recovery of the parasite.

RESULTS AND DISCUSSION

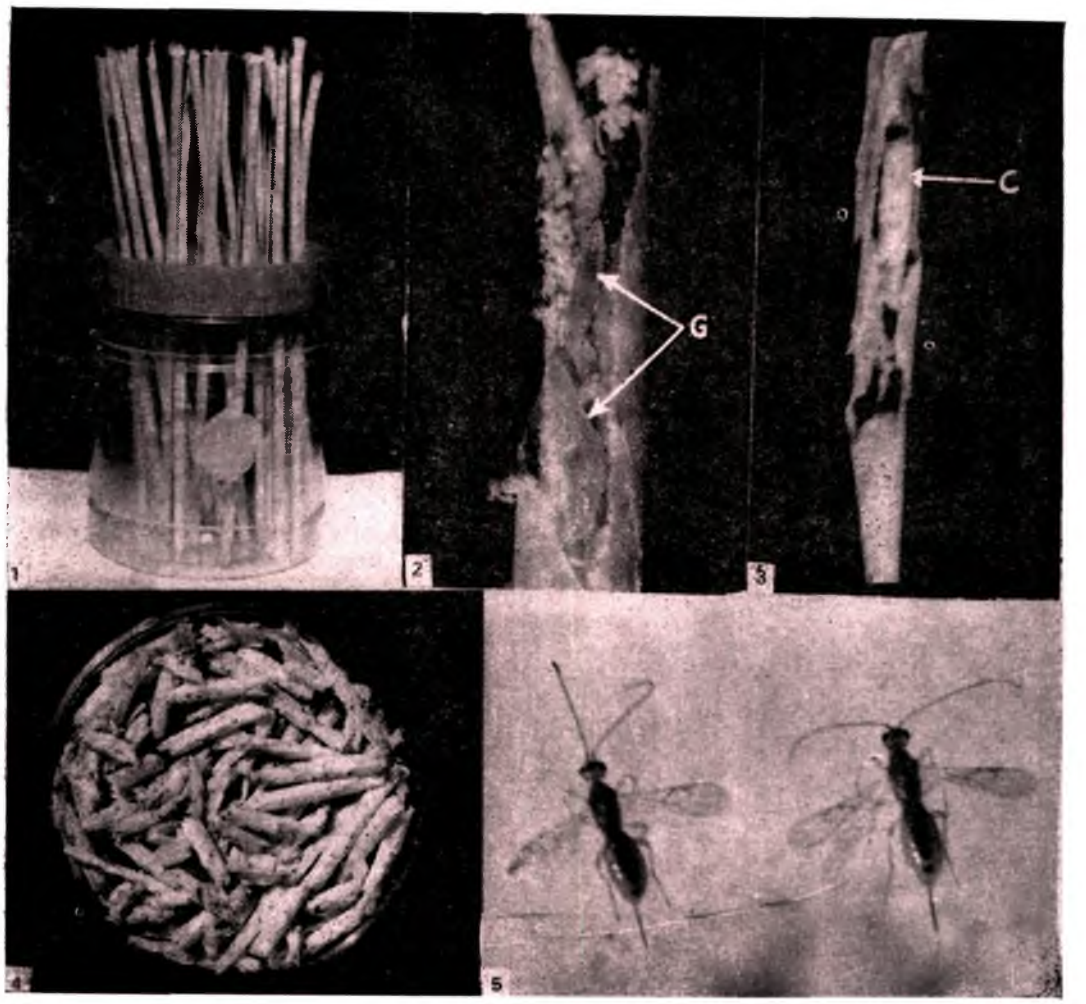
Biology of the parasite was studied using stalk borer as the host. Studies included duration of different stages, fecundity, longevity, effect of food on longevity, mating behaviour response of adults to different sugarcane borers and suitability of different borer species for laboratory rearing.

The parasite took an average 16.2 days (range 18–20 days) to complete its life-cycle. Incubation, larval and pupal periods ranged between 40–42 hours, 5–6 days and 10–12 days, respectively (at an average temperature of 25.1°C and R H of 76.5 per cent).

However when it was reared on maize borer the parasite took an average 18.1 days (range 18–20 days).

A female was capable of laying 25–30 eggs (mean 26.1 eggs) during its life span.

A male lived for 2–18 days (mean 8.8 days) while the female lived 5–42 days (mean 18.2 days) at an average temperature of 26.2°C and 69.0 per cent



Figs. 1—5. 1, rearing cage with host larvae in strawpipes and female and female adults for oviposition; 2, grubs(G) developing on host larvae; 3, cocoons(C) formed in situ; 4, harvested cocoons; 5, female adults of parasite, *A. pyralophagus*.

relative humidity while at lower temperatures (15°C constant temperature) female survived for 10-41 days with an average of 22.7 days. Feeding of the adults with pure honey solution, sugar solution, water in cotton swabs and without any substitute was studied. It was observed that soaking of cotton with distilled water is as good as any other food supplement (Table 1).

Thus under field conditions, water drops available in plenty may prove sufficient for survival of the adults for sufficient duration. The females readily mated after emergence. Mating was hundred per cent with 1 day old male while with male of 2 and 3 days old only 8.0 and 4.0 per cent mating was observed

TABLE 1. Effect of food on adult longevity. (temperature 25—27°C and percent mean relative humidity 70—85).

Food supplement	longevity of adult (n = 30)	
	male	female
Honey solution (50:50 Honey ; distilled water)	9.0 (5—10)*	12.4 (8—17)
Sugar solution 5%	9.8 (6—12)	24.8 (12—40)
Distilled water	15.0 (12—16)	16.7 (13—20)
Nil	3.9 (3— 5)	7.0 (3—10)

*Figures in parentheses are range.

TABLE 2. Suitability of different host larvae for the laboratory rearing of *A. pyralophagus*.

Host	number of larvae exposed	number of larvae parasitised	percent parasitisation	cocoons/ larvae (n = 30)
Chilo auricilius Dogn.	3,548	3,272	92.2	12 (1—48)*
Chilo partellus Swinh.	2,788	2,491	89.3	10 (1—45)
Emmalocera depressella Swinh.	55	43	78.2	12 (2—42)
Chilo sacchariphagus indicus Kapur	31	18	58.0	9 (2—20)
Acigona steniellus Hmpsn.	5	3	60.0	4 (2—6)
Chilo tumidicostalis Hmpsn.	4	2	50.0	4 (3—4)
Scirpophaga excerptalis W.	182	Nil	Nil	—
Sesamia inferens Wlk.	78	Nil	Nil	—
Corcyra cephalonica Staint.	78	Nil	Nil	—

(*Chilo infuscatellus* Snellen, the shoot borer was not available available at IISR, Lucknow hence not evaluated as laboratory host). * Figures in the parentheses are range.

Suitability of different hosts for the laboratory rearing of the parasite:

For the laboratory multiplication of the parasite, different species of sugarcane borer larvae, maize borer larvae and grain moth larvae were tried (Table 2). The parasite accepted all the borer larvae except top borer, *Scirpophaga excerptalis* W., pink borer, *Sesamia inferens* Walker and grain moth *Corcyra cephalonica* Staint.

Parasite has accepted six different species of hosts, however based on per cent parasitisation stalk borer, *C. auricilius* was observed to be the most suitable host followed by maize borer and root borer. (Thus the host range of the parasite is wide and this parasite could be able to surviue in the absence of other hosts in nature).

Field releases and recovery:

TABLE 3. Field releases of *A. pyralophagus* during two crop seasons.

Month	number of mated females released during different crop seasons.	
	1982—1983	1983—1984
October	500 (mixture)	56 (47)*
November	155 (44)	149 (73)
December	857 (265)	—
January	692 (—)	188 (53)
February	544 (93)	626 (211)
March	350 (80)	893 (355)
Total	3,098 (482)	1,912 (739)

*Number of males released along with females are in parentheses.

A total of 3,580 laboratory reared parasites in 1982–1983 and 2,651 parasites in 1983–1984 were released for field colonisation (Table 3).

Harvest data revealed the establishment of *A. pyralophagus* in the canes. A total of 12 cocoons in 1982–1983 and 32 cocoons in 1983–1984 crop seasons were recovered from 'released area'. Thus the parasite may prove a promising biotic agent in the management of stalk borer in the endemic areas of north Indian sugarcane belt. However, extensive field testing is needed to find out its ability to establish under varying agro-climatic conditions and to study its capability to survive under field conditions.

REFERENCES

AVASTHY, P. N. & N. K. TIWARI (1982) *Annual* report. I I S R., Lucknow, 85 pp.

BINDRA, O. S., N. CHAND & J. P. CHAUDHARY (1972) Assessment of *Lixophaga diatraeae* Tns. a tachinid fly for the control of sugarcane borers in Punjab. *J. Res. PAU Ludhiana*, **9**, 447—450.

BUTANI, D. K. (1972) Parasites and predators recorded on insect pests of sugarcane in India. *Indian Sugar*, **22**, 17—31.

KALRA, A. N. & J. CHANDRA (1980) Laboratory and field evaluation of two exotic dipterous parasites against sugarcane stalk borer, *Chilo auricilius* Ddgn. *Ind. J. agric. Res.*, **14** (1), 42—46.

MOHANRAJ, G. & A. P. SAXENA (1964) On the introduction into India of some tachinid parasites of sugarcane moth borers. *Tech Bull. Commonw. Inst. Biol. Control.*, 43.

RAO, V. P., T. SANKARAN K. C. MATHUR (1971) A review of the biological control of insects and other pests in South East Asia and Pacific region. *Tech. Communic. Commonw. Inst. Biol Control. Trinidad.* **6**, 34.

RAO, Y. R. V. J. & Y. S. RAO (1980) Suitability tests with indigenous and exotic natural enemies on *Chilo auricilius* Ddgn. in the laboratory. *Ind J. agric. Res.*, **14**, 169—199.

ROSA, SANTA (1983) Resultados las coseches Texas Ham sido Dados a conocer. *Sugar Y. Azucar*, **78** (8), 52 (English summary).

VARMA, ASHOK, P. N. AVASTHY & T. N. SRIVASTAVA (1975) Laboratory rearing of sugarcane stalk borer, *Chilo auricilius* Ddgn. through suceessive generations. *Indian Sugar*, **25** (3), 173—176.

VARMA, ASHOK & K. MITRA (1981) Recent researches leading to evolve a suitable control programme for stalk borer *Chilo auricilus* Ddgn. *Proc. National Symposium Stalk Borer*, 63—68.

YADAVA, S. R., J. N. GUPTA & J. P. CHAUDHARY (1981) Larval parasite in control of stalk borer. *Proc. National Symposium sugarcane Stalk Borer*, 90—98.

Entomon; 1987, *Vol.* **12**, *No.* 4, *pp.* 373 *to* 374

A REPORT ON THE OCCURRENCE OF *CULEX (CULICIOMYIA) HARRISONI* SIRIVANAKARN (1977) IN MANIPUR, INDIA

K. B. RAJPUT & T. K. SINGH

Department of Life Sciences, Manipur University, Imphal, Manipur, India 795 003

(Received 2 June 1986)

Occurrence of *Culex (Culiciomyia) harrisoni* Sirivanakarn was reported from Senapati District, Manipur State, India, for the first time.

(Key words: new record, India, *Culex (culiciomyia) harrisoni.*

Barraud (1934) described 7 species in the subgenus *Culiciomyia*. Out of these only 6 species were reported from Indian region. With the addition of *Culex (Culiciomyia) ramakrishnii* Wattal and Kalra (1965) from Dehra Dun (Uttar Pradesh), the total species in subgenus *Culiciomyia* from Indian region became 7 (Knight and Stone, 1977). During survey for mosquito fauna of Manipur State *Culex (Culiciomyia) harrisoni* Sirivanakarn was recorded during the year 1985, and the purpose of the present communication is to place on record the occurrence of the species in India.

A total of 2♂♂ aud 1♀ of *Culex (Culiciomyia) harrisoni* was reared from two larval collections from a high altitude locality Mao (1850 m) in Senapati district (approximate 25°30′N and 94°07′E) on 8 and 9 September 1985. Single male was reared from a discarded motor tyre from nearby forest to the human habitations. The tyre was containing clear water (pH 6) and was lying under dense tree shade with somewhat darkish illumination. One male and one female were reared from a horizontaly kept tar-drum having a small hole (approx. 45 × 20 cm) in the centre with clear water (pH 7) and no visible decaying matter. The drum was almost full with water. The larvae of the species were recorded to be breeding in association with *Uranotaenia bimaculate* Leicester, in tyre; and *Culex (Culiciomyia)*

Fig. 1. Male genitalia
(right gonocoxite removed)

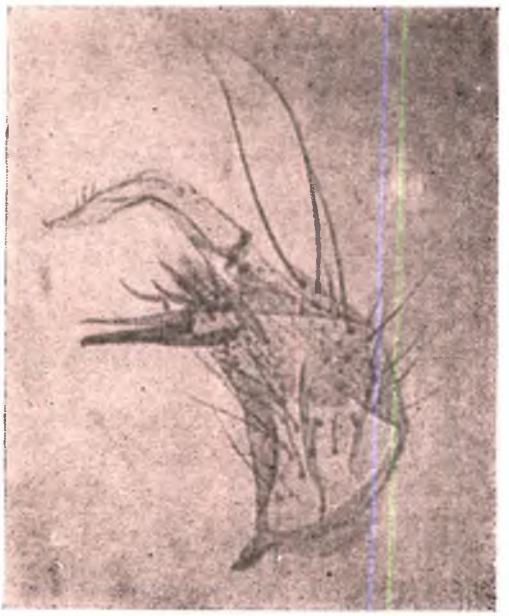


Fig. 2. Gonocoxite (ventral view)

pallidothorax Theobald, *Culex (Culex) quinquefasciatus* Say, in water collected in tar-drum.

The larvae were reared upto adult stage and the adults were identified and confirmed by genital preparation of males (Fig. 1 and Fig. 2), with the help of Barraud (1934) and Sirivanakarn (1977).

The species was reported earlier from Thailand (Chiang Mai, 600 m) only, from a rock pool inside a cave and seems to have distribution at high altitudes and preferring shady, darkish habitats with clear water having no vegetation for breeding.

REFERENCES

BARRAUD, P. J. (1924) A revision of the Culicine mosquitoes of India. Part XIV. The Indian species of subgenus *Culiciomyia* (Theo.) Edw., including one new species. *Indian J. Med. Res.*, **12**, 15—22.

BARRAUD, P. J. (1934) *The Fauna of British India including Ceylon and Burma, Diptera, Vol. V. Family Culicidae. Tribe Megarhinini and Culicini.* Taylor and Francis 463 p.

KNIGHT, K. L. & A. STONE (1977) *A Catalog of the Mosquitoes of the world (Diptera : Culicidae).* The Thomas Say Foundation, Entomological Society of America. 611 pp.

SIRIVANAKARN, S. (1977) Redescription of four oriental species of *Culex (Culiciomyia)* and the description of a new species from Thailand (Diptera : Culicidae). *Mosq. Syst.*, 9(2), 93—111.

WATTAL, B. L. & N. L. KALRA (1965) An entomological survey of Dehra Dun valley (Uttar Pradesh). Part II. Description of *Culex (Culiciomyia) ramakrishnii* sp. n., and allotype (♂) of *Uranotaenia maculipleura* Leicester, 1908. *Bull. ent. Soc. Mal. Com Dis.*, **26**, 09—313.

Entomon, 1987, *Vol.* **12**, *No.* **4**, *pp.* 375 *to* 377

A NEW SPECIES OF *RATBURELLA* (HOMOPTERA, CICADELLIDAE, TYPHLOCYBINAE) FROM DEHRA DUN (UTTAR PRADESH) INDIA

A. S. Sohi & J. S. Mann

Department of Entomology, Punjab Agricultural University, Ludhiana, Punjab, India 141 004

(Received 9 July 1986)

Ratburella biprocessa sp. nov. collected from *Mallotus philippiensis* at Dehra Dun (Uttar Pradesh) is described and illustrated. A key to the species of *Ratburella* is also included. Ramakrishnan and Menon (1973) described the genus *Ratburella* with *Ratburella unipunctata* as its type-species. Dworakowska (1977, 1980) described two new species, *Ratburella ornata* from Dehra Dun (Dworakowska, 1977) and *Ratburella (Burara) maxima* from Meghalaya (Dworakowska, 1980). In this paper, the fourth new species discovered by us in Dehra Dun is described and illustrated. A key to the species of *Ratburella* is also included.

(Key words : Ratburella biprocessa sp. nov., Dehra Dun)

Ratburella biprocessa sp. nov. (Figs. 1—13)

General body colour yellowish; head including eyes twice its median length; eyes ochraceous; vertex longer than broad, well produced beyond eyes medially and rounded anteriorly; coronal suture distinct, one milky white oval spot on either side of the coronal suture; pronotum declivous posteriorly, twice as broad as its median length.

Fore wing light yellowish having light brown colour in claval and first apical cell, two dark brown areas on either side of the wax field rounded apically. Hind wing elongate with two open apical cells. Abdominal apodemes reaching the base of the fourth abdominal segment.

Male genitalia :

Pygofer longer than broad, rounded caudally with a dorsal process, a group of microsetae on the disc. Anal tube appendage elongate and provided with spines where it joins anal tube. Male subgenital plate broader at base and gradually narrowing to beak-like apex, a group of macrosetae present on basal outer lobe and a row of microsetae before apex. Paramere elongate, convoluted at apex, pre-apical lobe placed just above the level of connective, three sensory pores present near the apical lobe; connective papilionaceous. Aedeagus with reduced preatrium and well developed dorsal apodeme, aedeagal shaft broad, stout, bearing a pair of basal processes, gonopore terminal.

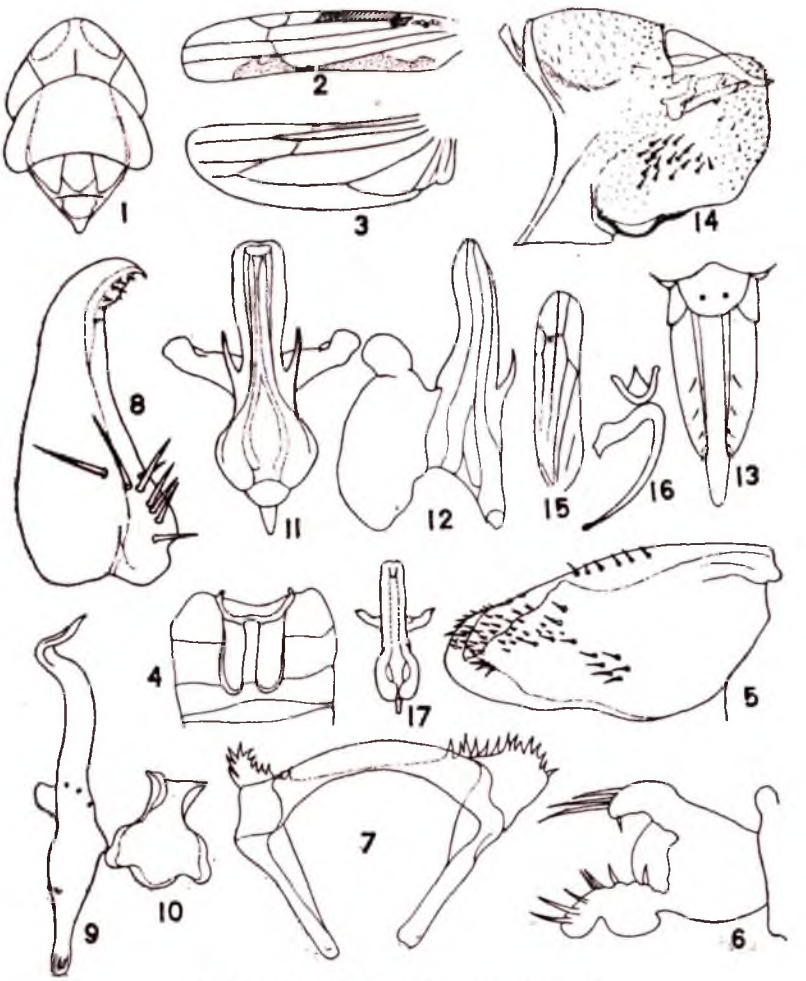
Female genitalia :

Seventh abdominal sternite of female dome-shaped with two light brown spots on either side of median line.

Measurements :

Holotype : Male

Head : Vertex length/breadth 0.45/0.94 mm. Interocular width (mean) 0.56 mm. Pronotum length/breadth 0.55/



Explanation to the Figures (1—17)

Ratburella biprocessa sp. nov. (Figs. 1—13) 1. Head and thorax; 2. Fore wing; 3. Hind wing; 4. Abdominal apodemes; 5. Pygofer; 6. Anal tube; 7. Anal tube processes; 8. Subgenital plate; 9. Paramere; 10. Connective; 11. Aedeagus (ventral view); 12. Aedeagus (lateral view); 13. Seventh sternum and ovipositor; 14. Pygofer of *Ratburella (Burara) maxima* (redrawn from Dworakowska, 1980); 15. Fore wing of *Ratburella* (s. str.) *unipunctata* (redrawn from Ramakrishnan and Menon, 1973); 16. Aedeagus (lateral view) of *Ratburella* (s. str.) *unipunctata* (redrawn from Ramakrishnan and Menon, 1973); 17. Aedeagus (ventral view) of *Ratburella* (s. str.) *ornata* (redrawn from Dworakowska, 1977)

1.02 mm. Scutellum length/breadth at base 0.41/0.70 mm. Fore wing length 3.5 mm. Total length of male 4.81 mm. Total length of female 5.13 mm.

Material examined :

5♂, 3♀, Holotype ♂, INDIA : Uttar Pradesh : Dehra Dun, Forest Research Institute, V.x.1985, ex *Mallotus philippiensis*, J. S. Mann and A. S. Sohi Coll., deposited in Division of Entomology, Indian Agricultural Research Institute, New Delhi (IARI). Paratypes : 4♂, 3♀, data as in holotype, deposited in IARI (1♂, 1♀), University of Agricultural Sciences, Bangalore (1♂, 1♀), Punjab Agricultural Universiry, Ludhiana (1♂, 1♀) and Biosystematics Research Institute, Ottawa, Canada (1♂).

Remarks :

This species is close to *Ratburella ornata* Dworakowska but differs by the presence of basal aedeagal processes, and more acutely pointed apex of male subgenital plate.

KEY TO SPECIES OF *RATBURELLA*

1. Pygofer lobe short and broad (Fig. 14)... .....*Ratburella (Burara) maxima*

— Pygofer lobe gradually narrowing caudally, longer than broad (Subgenus *Ratburella)*..... 2

2. Fore wing with a red spot in cell R (Fig. 15); paramere with an angular pre-apical extension, acutely pointed apically; aedeagal shaft thin, very long, spatulate apically (Fig. 16); male subgenital plate rounded caudally..... .....*Ratburella* (s. str.) *unipunctata*

— Fore wing without red spot in cell R, paramere convoluted apically and without pre-apical lateral extension, aedeagal shaft short and stout; male sub-genital plate acutely pointed caudally..... 3

3. Shaft of aedeagus with a pair of basal processes (Fig. 11)..... .....*Ratburella* (s. str.) *biprocessa* sp. nov.

— Shaft of aedeagus without basal processes (Fig. 17).....*Ratburella* (s. str.) *ornata*

Acknowledgements: The authors are thankful to Dr. Harcharan Singh, Professor and Head, Department of Entomology for providing the necessary research facilities and to the Indian Council of Agricultural Research, New Delhi for the financial assistance in the form of a research grant.

REFERENCES

DWORAKOWSKA, I. (1977) On some North Indian Typhlocybinae (Homoptera, Cicadellidae). *Reichenbachia Mus. Tierk.* Dresden, **16**(29), 283—346.

DWORAKOWSKA, I. (1980) On some Typhlocybinae from India (Homoptera, Cicadellidae). *Ent. Abh. Mus. Tierk.* Dresdrn, **43**(8), 151—201.

RAMAKRISHNAN, U. & M. G. R. MENON (1973) Studies on Indian Typhlocybinae (Homoptera, Cicadellidae). IV. Seven new genera with fourteen new species of Erythroneurini. *Oriental Ins.*, 7(1), 15—47.

Entomon, 1987, *Vol.* **12**, *No.* 4, *pp.* 379 *to* 383

TAXONOMIC STATUS OF TWO NORTH-EASTERN INDIAN SPECIES REFERRED TO GENUS *SYLEPTA* HUBNER WITH THE PROPOSAL OF A NEW GENUS *HEMOPSIS*

JAGBIR SINGH KIRTI & H. S. ROSE

Zoology Department, Punjabi University, Patiala Punjab India 147001.

(Received 9 July 1986)

Hemopsis n. gen. is proposed for *Sylepta* (=*Botys*) *dissipatalis* Lederer (type-species and *S. angustalis* is considered congeneric with it. This genus is completely diagnosed and is conspicuous by the absence of uncus in the male genitalia.

(Key words : Genus *Sylepta*, new genus)

The collection and identification of the Pyraustine moths of North-Eastern India from 1981 to 1983, revealed the occurrence of two species of the genus *Sylepta* Hubner i. e., *dissipatalis* Lederer and *angustalis* Snellen. These species have been briefly described by Hampson (1896, 1898) and listed as such by Klima (1939).

The genus name *Sylepta* is often erroneously spelled as '*Syllepte*' Hubner, which is a valid genus with *S. incomptalis* Hubner as the type-species. Munroe (1968) while pointing out this discrepancy referred this is a waste-basket genus (Munroe, 1976). Recently Fletcher and Nye (1984) not only followed Munroe (loc. cit.) but have also rectified that the name of the type-species of this genus is *incompatalis* Hubner and not *amendo* Cramer (Hampson 1896) or *amandalis* Hubner (Klima, 1939). Besides certain other morphological characters, the maculation of both the above mentioned species is quite different from the type-species *incompatalis* of the genus *Syllepte*, Apart from this, these species also fail to conform to the characterisation of some of the allied genera such as *Notarcha* Meyrick, *Nagiella* Munroe and *Haritalodes* Warren, once included as synonyms of *Sylepta* (Klima, 1939). In the light of these findings, *Hemopsis*, a new genus is proposed here for both of these congeneric species.

Hemopsis n. gen.

Type-species: *Botys dissipatalis* Lederer

Distribution: Oriental region.

Labial palpi obliquely upturned, reaching the level of vertex of head; third segment short and porrect. Maxillary palpi filiform. Frons rounded. Antenna simple, ciliated in male. Fore wing with discal cell less than half length of wing; vein R_1 originating from well before anterior angle of cell; R_5 curved, well separated from R_{3+4}; M_2, M_3 and Cu_1 from posterior angle of cell; Cu_2 from cell at three-fourths. Hind wing with tegmen slightly produced at vein Rs; discal cell one-third length of wing; M_2, M_3 and Cu_1 arising from the posterior angle of cell; Cu_1 curved and approximated to M_3 at base. Males with the outer proximal metathoracictibial spur minute. Male genitalia with uncus and gnathos absent; subscaphium not defined; valva with costa and sacculus clearly

differentiated; harpe present; aedeagus with vesica possessing complex armature. Female genitalia with corpus bursae avoid, signum marked by a well sclerotized are; ductus bursae marked with well developed colliculum.

A key to the two species of the genus *Hemopsis* n. gen. is given below:

Key to the species of genus *Hemopsis* n. gen.

Ground colour fuscous; fore wing without discocellular lunule; aedeagus with vesica possessing a bunch of small spine-like cornuti, arranged in a linear fashion..... .....*dissipatalis* Lederer

Ground colour ochreous; fore wing with a discocellular lunule; aedeagus with vesica possessing three spine-like cornuti, one short and the remaining two long and coiled..... ....*angustalis* Snellen

Hemopsis dissipatalis (Lederer) n. comb. (Figs. 1, 2, 3, 7, 8, 9)

Botys dissipatalis Lederer, 1863: 376, 474

Samea quinquigera Moore, Hampson, 1896: 335

Sylepta dissipatalis Lederer, Hampson, 1896: 335

Male genitalia: Uncus and gnathos missing; tuba analis very long; scaphium marked by a thin sclerotized line; subscaphium missing; tegumen longer than broad; vinculum narrow; saccus well defined. Valva broad, setose at tip; costa inflated, well sclerotized; sacculus with inner margin sinuate; harpe prominent. Transtilla membranous; juxta sclerotized. Aedeagus long and slender, with one of its walls strongly sclerotized; vesica possessing a bunch of spine-like cornuti.

Female genitalia: Corpus bursae baloon-shaped; signum represented by a semicircular sclerotized are-like structure; ductus bursae of moderate length, membranous, with distal part sclerotized; anterior apophyses long and narrow; posterior apophyses slightly less than half length of anterior apophyses; ovipositor lobes narrow, setose with short and long setae.

Wing Expanse (Half) : Male : 14 mm.
Female : 14 mm.

Material Examined : Assam: North Cachar hills, Jatinga, 3 ♂ ♂, 1 ♀, 8.12.ix.83; Mayur, 2 ♂ ♂, 1 ♀, 13.ix 83.

Distribution : Sikkim; Khasi hills.

Hemopsis angustalis (Snellen) n. comb. (Figs 4, 5, 6, 10).

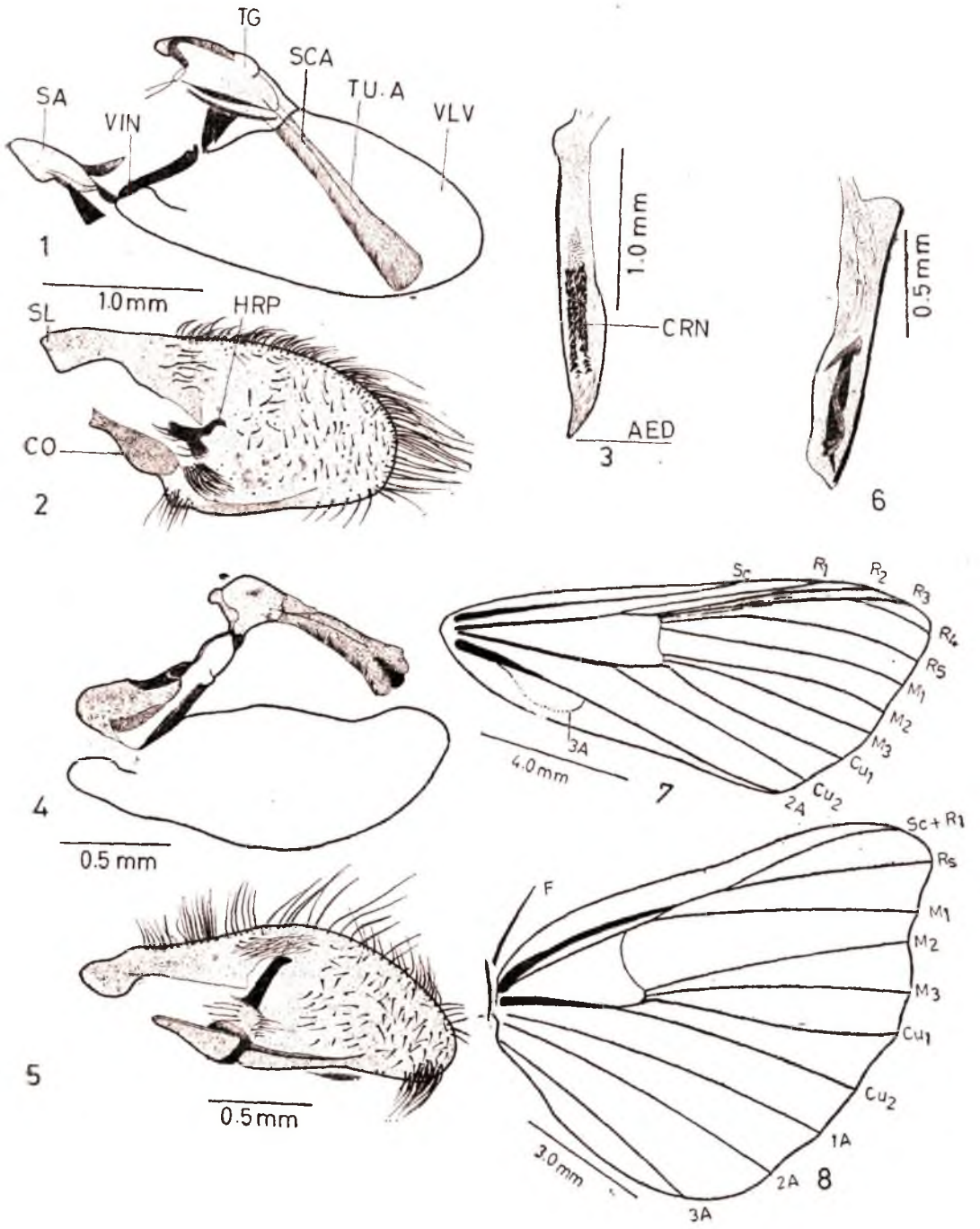
Sylepta angustalis Snellen, 1890: 585

Sylepta angustalis Snellen, Hampson, 1896: 333

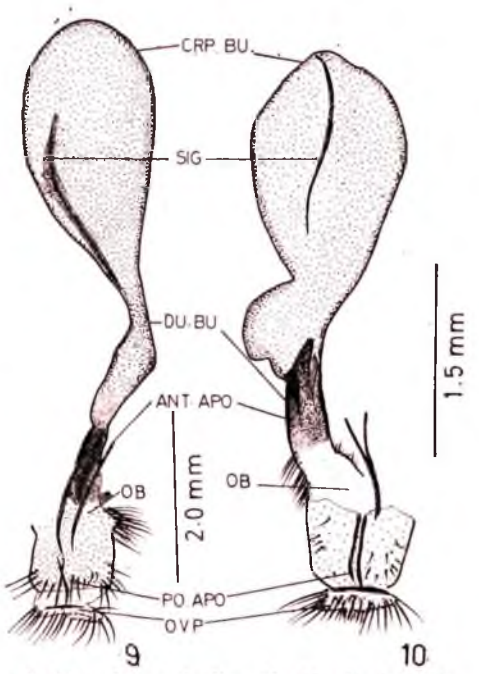
Male genitalia: Uncus and gnathos missing; tube analis long; scaphium marked by a thin sclerotized line; tegumen quite short; vinculum narrow, produced

---

Abbreviations: 1A—First anal vein; 2A—Second anal vein; 3A—Third anal vein; AED—Aedeagus; Ant. APO—Anterior apophyses; CO—Costa; CRN—Cornuti; CRP. BU—Corpus bursae; Cu_1—First cubital vein; Cur_2—Second cubital vein; DU. BU.—Ductus bursae; F—Frenulum; HRP—Harpe; M1—First median vein; M2—Second median vein; M3—Third median vein; OB—Ostium bursae; OVP—Ovipositor; PO. APO—Posterior apophyses; R1—First radial vein; R2—Second radial vein; R3—Third radial vein; R4—Fourth radial vein; R5—Fifth radial vein; RS—Radial sector; SA—Saccus; SC—Subcosta; SC+R1—Stalk of Sc and R1; LIG—Signum; SCA—Subscaphium; TG—Tegumen; TU. A—Tuba analis; VIN—Vinculum; VLV—Valva.



Explanation to Figures: Figs. 1, 2, 3 Male genitalia of *Hemopsis dissipatalis* (Lederer); 4, 5, 6 Male genitalia of *H. angustalis* (Snellen); 7, Forewing of *H. dissipatalis* (Lederer); 8, Hind wing of *H. dissipatalis* (Lederer).



9. Female genitalia of *H. dissipatalis* (Lederer); 10, Female genitalia of *H. angustalis* (Snellen).

into a prominent saccus. Valva with costa and sacculus inflated; harpe represented by a sclerotized spine. Transtilla small; juxta narrow. Aedeagus with vesica armed with three spine-like cornuti, one small and remaining two long and coiled.

Female genitalia: Corpus bursae oval; signum marked by a highly sclerotized arc in the middle; ductus bursae short, heavily sclerotized distally; ostial region simple; anterior apophyses long and narrow, without any expansions; posterior apophyses strongly sclerotized; ovipositor with densely setose narrow lobes.

Wing Expanse (Half) : Male : 14 mm–15 mm.
Female : 14 mm.

Material Examined : Meghalaya: Khasi hills, Upper Shillong, 2 ♂ ♂, 31.xiii.82; Cheerapunjee, 5 ♂ ♂, 13.v.83; Nagaland: Kohima, University Campus, 1 ♀, 9.v.83.
Distribution : Sikkim and Khasi hills.

Remarks: The type-species *incomtalis* Hübner (repository not known) of the genus *Syllepte* Hubner though could not be studied personally but the comparision of the maculation of the species *dissipatalis* Lederer and *angustalis* Snellen with its transperancy prepared from the figured adult (Hubner: 1823, Zutrege famml. ent. 2:18) quite different and it can be safely inferred that they belong to a natural group other than *incomptalis*. The wing venation and the structure of the male and female genitalia of both these species differs from the type-species *derogata* Fabricius, *desmialis* Walker and *multilinealis* Guenee of the genera *Notarcha* Meyrick, *Nagiella* Munroe and *Haritalodes* Warren respectively, which have been revived from the synonymy of genus *Sylepta* (Sauter, 1973, Munroe, 1976). The absence of the uncus, structure of tegumen, armature of valva in the male genitalia and the presence of long arc-like signum in the corpus bursae in the female genitalia make these species conspicuous. Hence a new genus, *Hemopsis* is proposed on the type-species *Botys dissipatalis* Lederer and the second species *angustalis* Snellen considered congeneric is also transferred to the new genus, both forming new combinations as *Hemopsis dissipatalis* (Lederer) and *H. angustalis* (Snellen). The new genus is named after the first name of an eminent entomologist, late Dr. Hem Singh Pruthi.

The absence of the uncus in the new genus takes it nearer to *Bocchoris* Moore from which it otherwise differs in the structure of labial palpi and wing venation. The absence of the uncus has also been reported in two other Pyraustine genera i.e., *Diasemia* Hubner and *Choristostigma* Warren (Munroe, 1957).

Acknowledgements: The authors are thankful to the University Grants Commission, New Delhi for funding the project and allowing

Dr. H. S. Rose to visit British Museum (Nat. Hist), London, for the comparison of the species. The help rendered by Dr. Gaden S. Robinson, Head Microlepidoptera section and Mr. M. Shaffar, Pyralid specialist of British Museum (Natural History), London is acknowledged heartily.

REFERENCES

FLETCHER, D. S. & I. W. B. NYE (1984) *The Generic Names of Moths of the World.* **5**, 1—185.

HAMPSON, G. F. (1896) *Fauna of British India. Moths*, **4**, Taylor & Francis Ltd., London. 1—594.

HAMPSON, G. F. (1898) A revision of the moths of subfamily Pyraustinae and family Pyralidae. Part 2. *Proc. Zool. Soc. London*, 590—761.

KLIMA, A. (1939) Lepidopterorum Catalogus Pyralididae : Subfam. Pyraustinae, Vol. **89 & 94**, S-Gravenhage. 1—384.

LEDERER, J. (1863) Beitrage Zur Kenntniss Der Pyraliden. *Wien. Ent. Monatschr.*, **7**, 243—502.

MUNROE, E. (1957) North American components of the genus *Diasemia* of authors (Lep., Pyralidae). *Can. Ent.*, **89**, 146—170.

MUNROE, E. (1968) New species of *Apilocrocis*, with a key to known species (Lep., Pyralidae). *Can. nt.*, **100**, 441—448

MUNROE, E. (1976) New genera and species of Pyraustinae (Lep., Pyralidae), mainly from the collection of the British Museum (Natural History), London, *Can. Ent.*, **108**(8), 873—884.

SAUTER, W. (1973) Retinaculum as a systematic characteristic in Pyralidae (Lep., Pyralidae). *Beitr. Naturb. Forsch Sudw Dt.*, **32**, 161—168.

SNELLEN, P. C. T. (1890) A Catalogue of the Pyralidina of Sikkim Collected by Henry J. Elwes and the late Otto Moller. *Trans. Ent. Soc. London*, 557—647.

Entomon, 1987, *Vol.* 12, *No.* 4, *pp.* 385 *to* 390

HOST-SPECIFICITY OF *NEOCHETINA BRUCHI* HUSTACHE (COLEOPTERA : CURCULIONIDAE) INTRODUCED INTO INDIA FOR BIOLOGICAL CONTROL OF WATER HYACINTH

K. P. JAYANTH & SUDHA NAGARKATTI[1]

All India Coordinated Research Project on Biological Control of Crop Pests and Weeds, Indian Institute of Horticultural Research, Hessaraghatta Lake Post, Bangalore, India 560089

(Received 9 July 1986)

The host specificity of *Neochetina bruchi* Hustache (Col.: Curculionidae), imported for biological control trials against water hyacinth in India, was studied under quarantine conditions. Seventy-six species of plants representing 42 families were tested. The weevil did not feed or oviposit on 58 of the test plants. The adults were observed to nibble on 9 and fed slightly on another 5 plants without laying eggs. Slight feeding and oviposition were observed on *Trapa bispinosa, Vallisneria* sp., *Amaryllis* sp. and *Lactuca sativa*. But larvae that hatched out were unable to complete development on any of these plants, confirming that *N. bruchi* is safe for field releases against water hyacinth in India.

(*Key words: Neochetina bruchi*, water hyacinth, biological bcontrol)

INTRODUCTION

Water hyacinth (*Eichhornia crassipes*) is the most serious aquatic weed in India covering more than 200,000 ha of water surface (ANON, 1979). Because of its fast growth and rapid multiplication, mechanical and chemical methods of control are ineffective besides being expensive requiring repeated applications. Over the last decade utilization has been considered as one of the control methods (ANON, 1976). However, GOPAL (1984) has cautioned that utilization is unlikely to control the weed and may lead to a perpetuation of the problem.

Biological control efforts in India were initiated in 1982 under the All India Coordinated Research Project on Biological Control of Crop Pests and Weeds. Two insects *Neochetina eichhorniae* Warner and *N. bruchi* Hustache (Col: Curculionidae) and a mite *Orthogalumna terebrantis* Wallwork (Acari : Galumnidae) were introduced from U S A for quarantine testing. Host-specificity tests with *N. eichhorniae* proved its safety for release in India (NAGARKATTI & JAYANTH, 1984) and field trials are now in progress. The present paper describes the results of host-specificity tests conducted with *N. bruchi*.

MATERIALS AND METHODS

N. bruchi was multiplied under quarantine conditions in a glass house within 60.5 × 40.5 × 30.5 cm plastic troughs. Water collected from lakes and tanks was filled into

Contribution No. 90/86 of the Indian Institute of Horticultural Research, Bangalore.

[1] Present address: North Carolina Dept. of Agriculture, 11130 Blue Heron Drive, Pineville, N. C. 28134, U. S. A.

the troughs and 10 pairs of adults were released after placing 20 water hyacinth plants in each. These troughs were then kept covered with insect proof cages made of nylon wire mesh and cloth with clear polythene sheet at the top for admitting light. The cages were supported on the troughs by wrought iron frames and their bottom ends attached firmly to the rims of the troughs with the help of aluminium strips and screws.

Starvation and multiple choice tests were carried out. In the starvation test 5 freshly emerged adults each of *N. burchi* were confined within 11 × 14 cm plastic containers with individual test plants. Aquatic plants were placed directly in the jar with tank water while terrestrial plants were provided in the form of a bouquet with water in 50 ml plastic containers. Cotton pads soaked in water were also provided inside the jars for increasing humidity.

Observations were recorded on feeding oviposition and mortality of the adults. Eggs laid by *N. bruchi* on test-plants were further observed for hatching and larval development. All the plants on which feeding or oviposition by *N. bruchi* had been observed were provided together in a plastic trough with a single water hyacinth plant for the multiple choice test, which was replicated three times.

RESULTS AND DISCUSSION

A total of 76 plants representing 42 families were tested and feeding or oviposition were not observed on 58 of them (Table 1), although adults survived for 17 to 53 days in the total absence of water hyacinth.

Slight nibbling as evidenced by scraping of leaf epidermis was observed on 9 plants (Table 2), of which only *Hydrilla verticillata* is aquatic and could conceivably be suitable for feeding. But even this, being a submerged plant, would be unacceptable under normal conditions. The adults of *N. bruchi* did not oviposit on any of the above plants.

The adult weevils fed and survived for periods ranging from 34 to 76 days on *Pistia stratiotes*, *Canna indica*, *Tradescantia fluminensis*, *Zebrina pendula* and *Musa paradisiaca* (Table 3) Among these *P. stratiotes* alone is aquatic and is considered to be a weed. Adults were incapable of ovipositing on any of the above plants. Even though *N. bruchi* larvae were introduced inside the tissues of the above plants they were unable to survive for more than 3 days in any of the plants.

Table 4 lists the four test plants on which feeding and oviposition by *N. bruchi* were observed. In case of *Amaryllis* sp. a single infertile egg was laid in decaying plant tissue. Two fertile eggs were laid on *Lactuca sativa*, but the larvae that hatched out died within 2 days. Both the above plants are terrestrial and would not be suitable for pupation by *N. bruchi* as live roots of water hyacinth are required for successful pupation and adult emergence (DELOACH & CORDO, 1976). In the case of *Vallisneria* sp. 3 fertile eggs were laid but the larvae that hatched out did not survive for more than 2 days.

N. bruchi laid 5 eggs on *Trapa bispinosa* but newly hatched larvae died within 3 days. In further tests 25 half and full grown larvae were released inside the bulbous petioles of 5 *Trapa* plants by puncturing the epidermis. None of the larvae were able to survive for more than 4 days. When full grown larvae, that had started spinning cocoons on water hyacinth roots were released on the roots of *Trapa*, pupation was not successful.

In the multiple choice tests, feeding and oviposition were observed only on water hyacinth, while all the other 18 plants on which nibbling or feeding were observed in starvation tests were left untouched. The results of this study conclusively shows that *N. bruchi* is

TABLE 1. Test plants on which feeding by *Neochetina bruchi* was not observed.

Sl. no.	Family	Species	Common name	Max. no. of days survived
1	2	3	4	5
1	Amaryllidaceae	*Polyanthes tuberosa*	Tube rose	19
2	,,	*Hymenocallis* sp.	Spider lily	30
3	Anonaceae	*Anona squamosa*	Custard apple	33
4	Anacardiaceae	*Mangifera indica*	Mango	29
5	Araceae	*Syngonium* sp.	—	38
6	Bromeliaceae	*Ananas comosus*	Pineapple	36
7	Caricaceae	*Carica papaya*	Papaya	22
8	Chenopodiaceae	*Beta vulgaris*	Beet root	46
9	Compositae	*Helianthus annuus*	Sunflower	34
10	Convolvulaceae	*Ipomoea batatas*	Sweet potato	22
11	Cruciferae	*Brassica juncea*	Mustard	37
12	,,	*B. oleracea*	Cabbage	41
13	Cucurbitaceae	*Cucurbita maxima*	Pumpkin	33
14	,,	*Cucumis sativus*	Cucumber	46
15	,,	*Citrullus vulgaris*	Water melon	36
16	Euphorbiaceae	*Ricinus communis*	Castor	22
17	,,	*Codiaeum variegatum*	Croton	47
18	,,	*Manihot utilissima*	Tapioca	25
19	Graminaceae	*Oryza sativa*	Rice	30
20	,,	*Eleusine coracana*	Ragi	25
21	,,	*Triticum vulgare*	Wheat	34
22	,,	*Sorghum vulgare*	Jowar	27
23	,,	*Bambusa tulda*	Bamboo	35
24	,,	*Zea mays*	Maize	29
25	,,	*Sacharum officinarum*	Sugarcane	37
26	Leguminosae	*Arachis hypogaea*	Groundnut	43

Countd. next page

1	2	3	4	5
27	,,	*Pisum sativum*	Pea	30
28	,,	*Albizzia lebbek*	—	37
29	Liliaceae	*Allium cepa*	Onion	17
30	Malvaceae	*Abelmoschus esculentus*	Bhendi	47
31	,,	*Gossypium arboreum*	Cotton	35
32	Moraceae	*Artocarpus heterophyllus*	Jack fruit	39
33	Moraceae	*Ficus carica*	Fig	24
34	Myrtaceae	*Psidium guajava*	Guava	53
35	Nymphaceae	*Nymphaea* sp.	Water lily	51
36	Oleaceae	*Jasminum nudiflorum*	Jasmine	23
37	Palmaceae	*Cocos nucifera*	Coconut	35
38	,,	*Areca catechu*	Betel nut	36
39	Parkeriaceae	*Azolla pinnata*	—	27
40	Piperaceae	*Peperomia* sp.	—	30
41	Punicaceae	*Punica granatum*	Pomegranate	41
42	Rosaceae	*Rosa alba*	Rose	32
43	Rubiaceae	*Coffea robusta*	Coffee	22
44	Rutaceae	*Citrus medica*	Lime	32
45	,,	*Murraya exotica*	Curryleaf	30
46	Sapotaceae	*Achras zapota*	Sapota	39
47	Solanaceae	*Solanum tuberosum*	Potato	25
48	,,	*S. melongena*	Brinjal	31
49	,,	*Capsicum annum*	Chilli	53
50	,,	*Lycopersicum esculentum*	Tomato	24
51	Theaceae	*Thea sinensis*	Tea	25
52	Umbelliferae	*Coriandrum sativum*	Coriander	31
53	,,	*Dacus carota*	Carrot	49
54	Verbenaceae	*Tectona grandis*	Teak	35
55	Vitaceae	*Vitis vinifera*	Grape	28
56	Zingiberaceae	*Zingiber officinale*	Ginger	34
57	,,	*Curcuma longa*	Turmeric	34
58	,,	*Elettaria cardamomum*	Cardamom	27

TABLE 2. Test plants on which nibbling by *Neochetina bruchi* was observed.

Sl. no.	Family	Species	Common name	Max. no. of days survived
1	Araceae	*Colocasia esculenta*	Arvi	43
2	,,	*Amorphophallus* sp.	Yam	31
3	Begoniaceae	*Begonia* sp.	—	24
4	Cruciferae	*Raphanus sativus*	Radish	50
5	Hydrocharitaceae	*Hydrilla* sp.	—	47
6	Labiatae	*Mentha arvensis*	Mint	39
7	Leguminosae	*Dolichos lablab*	Lablab	18
8	,,	*Vigna sinensis*	Cowpea	37
9	Orchidaceae	*Vanilla fragrans*	Vanilla orchid	36

TABLE 3. Test plants on which feeding by *Neochetina bruchi* was observed

Sl. no.	Family	Species	Common name	Max. no. of days survived
1	Araceae	*Pistia stratiotes*	—	76
2	Cannaceae	*Canna indica*	Canna	34
3	Commelinaceae	*Tradescantia fluminensis*	—	51
4	,,	*Zebrina pendula*	Wandering jew	36
5	Scitamineae	*Musa paradisiaca*	Banana	56

TABLE 4. Test plants on which feeding and oviposition by *Neochetina bruchi* were observed.

Sl. no.	Family	Species	Common name	Max. no. of days survived
1	Amaryllidaceae	*Amaryllis* sp.	—	40
2	Compositae	*Lactuca sativa*	Lettuce	34
3	Hydrocharitaceae	*Vallisneria* sp.	—	38
4	Onagraceae	*Trapa bispinasa*	Water chestnut	42

incapable of completing its development on any plant except water hyacinth and is therefore safe for field liberation in India. This confirms the studies conducted earlier in Argentina and U S A (De Loach, 1976 a; Perkins & Maddox, 1976).

Although *N. eichhorniae* and *N. bruchi* have very similar life histories (De Loach & Cordo, 1976) both were imported as they exhibit subtle differences. De Loach & Cordo (1976) had found that *N. bruchi* had a faster rate of increase and a shorter generation time and they oviposited at different locations within the plant and had different responses to temperature. De Loach (1976b) reported that in Argentina the two species of weevils alternate in abundance throughout the year. It is hoped that *N. eichorniae* & *N. bruchi* will be able to complement each other in India by attacking plants in different growth stages and at different times of the year.

Successful biological control of water hyacinth by *N. bruchi*, within 6 years after releases, was reported in an isolated artificial reservoir in Argentina (De Loach & Cordo, 1983). Permission of the Plant Protection Advisor to Govt. of India for conducting field trials with *N. bruchi* was obtained in September 1983 and field releases are now in progress.

Acknowledgements: The authors are grateful to Dr. Ted Center, U. S. Department of Agriculture, Fort Lauderdale, Florida, U S A, and to the Commonwealth Institute of Biological Control for their help in procuring stocks of *N. bruchi* and also to the latter for the use of their quarantine facilities at Bangalore. They are also grateful to Mr. S. K. Jalali for technical assistance given and to the Director, Indian Institute of Horticultural Research, Bangalore for facilities provided.

REFERENCES

Anonymous (1976) Making aquatic weeds useful: Some perspectives for developing countries. National Academy of Sciences, Washington, 175 pp.

Anonymous (1979) Recommendations of the task force on water hyacinth, Govt. of India, Min. of Agric. and Irrigation (Dep. Agric. and Co-op.), New Delhi, 18 pp.

De Loach, C. J. (1976 a) *Neochetina bruchi*, a biological control agent of water hyacinth. Host specificity in Argentina, *Ann. Ent. Soc. Am.*, **69**, 635—642.

De Loach, C. J. (1976 b) Ecological studies of *Neochetina bruchi* and *N. eichhorniae* on water hyacinth in Argentina. *J. Aquatic Plant Management*, **14**, 53—59.

De Loach, C. J. & H. A. Cordo (1976) Life cycle and biology of *Neochetina bruchi*, a weevil attacking water hyacinth in Argentina, with notes on *N. eichhorniae*. *Ann. Ent. Soc. Am.*, **69**, 643—652.

De Loach, C. J. & H. A. Cordo (1983) Control of water hyacinth by *Neochetina bruchi* (Coleoptera : Curculionidae : Bagoini) in Argentina. *Environ. Ent.*, **12**, 19—23.

Gopal, B. (1984) Utilization of water hyacinth as a new resource or for its control : Some environmental considerations, 193—206, *in: Water hyacinth* Ed. Thyagarajan, G. UNEP Reports and Proc. Series, 7, 1005 pp.

Nagarkatti, S. & K. P. Jayanth (1984) Screening biological control agents of water hyacinth for their safety to economically important plants in India. 1. *Neochetina eichnorniae* Warner (Col., Curculionidae). 868—883. *in*: *Water Hyacinth* Ed. Thyagarajan, G. UNEP Reports and Proc. Series, 7 1005 pp.

Perkins, B. D. & D. M. Maddox (1976) Host specificity of *Neochetina bruchi* Hustache (Coleoptera, Curculionidae), a biological control agent for water hyacinth.

Entomon, 1987, *Vol.* **12**, *No.* 4, *pp.* 391 *to* 396

REPORTS AND NEW RECORDS

RECORD OF *SAHYADRASSUS MALABARICUS* (MOORE) DAMAGING *GLIRICIDIA MACULATA*, A STANDARD OF BLACK PEPPER *PIPER NIGRUM* IN KERALA[1]

S. Devasahayam, T. Premkumar &
K. M. Abdulla Koya

Central Plantation Crops Research Institute
Regional Station, Marikunnu P. O.,
Calicut, India 673 012

(Received 7 March 1986)

Caterpillars of *Sahyadrassus malabaricus* (Moore) were recorded for the first time damaging *Gliricidia maculata*, a standard used for training black pepper vines *Piper nigrum* in Kerala. Notes on the nature of damage caused by the borer and its other hosts are reported.

(Key words: Sahyadrassus malabaricus, Gliricidia maculata, black pepper, *Piper nigrum)*

Gliricidia maculata is used as a standard for training black pepper vines *Piper nigrum* in certain tracts of Kerala. During September-October 1985 a large number of standards of *G. maculata* were found damaged by caterpillars of *Sahyadrassus* malabaricus (Moore), Syn. *Phassus malabaricus* Moore (Lepidoptera : Hepialidae) at the farm of the Central Plantation Crops Research Institute at Peruvannamuzhi (Calicut district, Kerala); this is the first record of the borer on the plant. Notes on the nature of damage caused by the borer and its other hosts are reported here.

Caterpillars of various stages were observed on *G. maculata* standards and the maximum recorded length was 8.5 cm. They were creamy white with a black head capsule. The dorsal sclerites of the thoracic and abdominal segments were brownish. The caterpillar bores a cylindrical tunnel longitudinally along with pith of the stem. In many cases the tunnel extends into the taproot region in the soil. The anterior end of the tunnel is curved before it opens to the outside. The opening of the tunnel is covered by a mat-like frass material consisting of coarse wood particles spun together with the silk secreted by the caterpillar. The size of this mat like structure depends on the stage of infestation. This structure is a characteristic feature indicating the presence of the borer inside. Around the opening of the tunnel the stem is girdled in the form a ring resulting in the formation of callus above the girdled region.

The caterpillar scrapes and feeds on the plant tissues around the opening of the tunnel and the callus region. The tunnel opening was found to occur generally at a height of 6-26 cm from the base but sometimes upto a height of 185 cm and plants having a girth of 3.5—5.5 cm were found to be infested. The leaves of the infested plants turn yellow and drop and the stem above the point of girdling dries up completely. A sample survey conducted at the farm during October 1985 showed that 12 per cent of the standards were damaged. Generally a single infestation occurred on a plant; however, in rare cases the infestation was found to occur at 2 or 3 places. Though recognition of the damage seems to be easy, since the base of the standards are covered with mulch and weeds, detection in early stages is difficult.

The life history and larval habits of the borer have been studied by Beeson (1941) and Nair (1982). The damage caused to *G. maculata* is in general similar

[1] Contribution No. 515 of Central Plantation Crops Research Institute, Kasaragod 670124, Kerala.

to that reported in other plants by them. *S. malabaricus* has a wide host range occurring on 44 plants belonging to 24 families (including economically important ones such as red gram, brinjal and saplings of pear, tea, clove, sandalwood, teak and eucalypts) and has been listed by NAIR (1985). *S. malabaricus* was also observed to infest *Cajanus cajan* (red gram), *Acacia auriculiformis* and *Ailanthus malabaricus* growing adjacent to the *G. maculata* plants at Peruvannamzhi. However, in these plants complete girdling of the stem did not occur and the latter two species of plants did not succumb to the attack.

Acknowledgement: We are thankful to Dr. PRATAP SINGH, Entomologist, Forest Research Institute and Colleges, Dehra Dun for confirming the identify of the specimen.

REFERENCES

BEESON, C. F. C. (1941) *The Ecology and Control of the Forest Insects of India and the Neighbouring Countries*, 1961 Reprint, Government of India. 767 pp.

NAIR, K. S. S. (1982) Seasonal incidence. host range and control of the teak sapling borer, *Sahyadrassus malabaricus*. KFRI Research Report 16, Kerala Forest Research Institute, Peechi, Kerala, India. 36 pp.

FUSARIUM PALLIDOROSEUM (COOKE) SACC. AS A FUNGAL PATHOGEN OF *APHIS CRACCIVORA* KOCH.

V. HAREENDRANATH, K. P. VASUDEVAN NAIR & SUMA PAULOSE

Division of Entomology, College of Agriculture, Vellayani, Trivandrum, India 695 522

(Received 3 Aprial 1986)

A fungal pathogen *Fusarium pallidoroseum* (Cooke) Sacc. was found for the first time as pathogenic to pea aphid *Aphis craccivora* Koch.

(Key words: fungal pathogen, *Fusarium pallidoroseum* (Cooke) Sacc, *Aphis craccivora* Koch)

The pea aphid, *Aphis craccivora* Koch, is a serious pest of pulses. It is also reported as a vector of many disease causing viruses *A. craccivora* on cowpea was observed dead in large numbers during August-September 1985 at the Agricultural college Farm, Vellayani Kerala. The dead mummified insects had white mycelial growth over the body.

The fungus was isolated in pure culture on potato dextrose agar from the dead insects and identified as *Fusarium pallidoroseum* (Cooke) Sacc. Pathogenicity tests conducted by spraying a spore

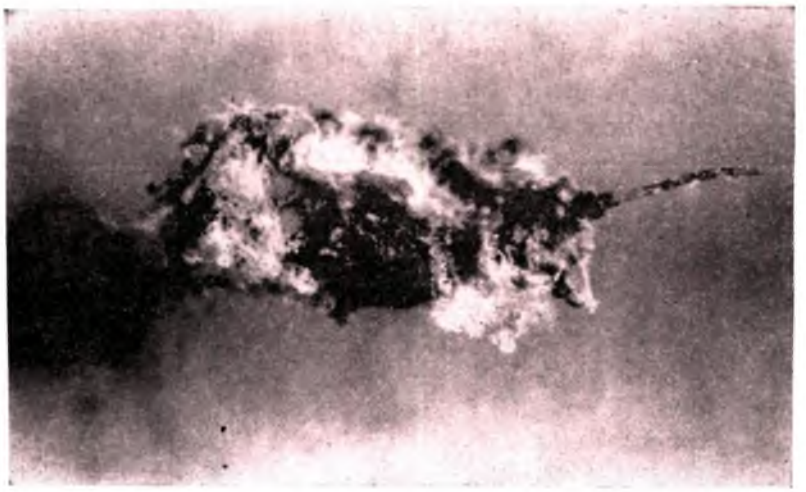


Fig. 1. Growth of *F. pallidoroseum* on *A. craccivora*

Fig. 2. Conidia of *F. pallidoroseum*

suspension prepared from nine day old culture of the fungus showed cent per cent mortality of nymphs and adults of pea aphid. Fourteen species of Entomophthora ore reported pathogenic to aphids. Other fungi reported on aphids include species of *Cephalosporium*, *Cladosporium*, *Acrostalagmus*, *Hirusutella* and *Paecilomyces* (GUSTAFSSON, 1971). This is the first record of *F. pallidoroseum* as a pathogen of *A. craccivora*.

Complete mortality of infected pea aphids occurred in 36 to 72 hours. The cadavers turned dirty black and were hard to touch. The mummified cadavers were firmly attached to the plant. External mycelial growth appeared 24–48 hours after death. The dead insects were covered by a fluffy white mycelial growth of the fungus in 72 hours (Fig. 1).

The characteristics of the fungus observed in artificial culture were as follows:- Aerial mycelium is white in colour, a pale yellow discolouration of the medium is observed when growth advances, conidia are of two types, primary and secondary, conidia scattered in aerial mycelium and slightly curved, sickle shaped with thicker central portion tapering towards both ends, conidia are 0–7 septate (Fig. 2).

Acknowledgement: The authors are grateful to Dr. D. BRAYFORD, Commonwealth Mycological Institute, Kew, Surrey, England for identifying the fungus.

REFERENCE

MAGNUS GUSTAFSSON, (1971) Microbial control of aphids and scale insects., 375—384, in: *Microbial Control of Insects and Mites*, (H. D. Burges and NW Hussey eds). Academic Press, New York, p. 371—384.

OCCURRENCE OF A FUNGAL DISEASE ON SUGARCANE SHOOT BORER, *CHILO INFUSCATELLUS* SNELL

S. EASWARAMOORTHY & G. SANTHALAKSHMI

Division of Entomology, Sugarcane Breeding Institute, Coimbatore, India 641 007

(Received 3 April 1986)

Beauveria nr. *bassiana* Vuill., a fungal pathogen was found pathogenic to sugarcane shoot borer, *Chilo infuscatellus* Snell.

(Keywords: Beauveria nr. *bassiana*, fungal pathogen, sugarcane shoot borer, *Chilo infuscatellus* Snell.)

During the survey of sugarcane shoot borer, *Chilo infuscatellus* Snell. (Crambidae: Lepidoptera) in Tamil Nadu, a number of larvae were found to be infected and mummified by a fungal pathogen. The dead larva was hard and brittle and the body covered with a white fungal mat.

The pathogen was isolated in pure culture on Czapek's dox agar medium and was identified as *Beauveria* nr. *bassiana* Vuill. Pathogenicity tests were conducted by spraying spore suspension of diffferent concentrations of the fungus obtained from 10 days old culture along with a surfactant. Third instar shoot borer larvae were used for this study and after treatment the larvae were reared on sugarcane shoot bits (DAVID *et al.*, 1980) at 24 ± 2°C and 75 ± 10 per cent relative humidity. In the initial stage of infection, the treated larvae showed sluggishness, loss of sensitivity and

Institute publication No. 919

appetite. Mortality occurred in 6 to 16 days. The percentage mortality observed was 43.3, 46 7, 53.3 and 60.0 respectively with concentrations of 10^4, 10^5, 10^6 and 10^7 spores/ml of spray fluid. Mycelial growth appeared a few hours after the death of the larvae and the cadavers were completely covered by the fungus in two or three days when placed over a moist filter paper.

This is the first time that *B.* nr. *bassiana* is observed as a pathogen infecting *C. infuscatellus* though *B. bassiana* is reported earlier on sugarcane stalk borer, *Chilo auricilius* Ddgn. (VARMA & MITRA, 1981) and on white grubs *Holotrichia consanguinea* Blanch. (RAO & VIJAYALAKSHMI, 1959).

Acknowledgement: The authors are grateful to Dr. K. MOHAN NAIDU, Director and Dr. H. DAVID, Head, Division of Entomology. Sugarcane Breeding Institute, Coimbatore for the encouragement and Dr. D. N. ROBERTS, Boyce Thompson Institute, USA for identifying the pathogen.

REFERENCES

DAVID, H., S. EASWARAMOORTHY, V. NANDAGOPAL, M SHANMUGASUNDARAM, G. SANTHALAKSHMI, M. ARPUTHAMANI & N. KUNJUKRISHNA KURUP (1980) Laboratory studies on *Sturmiopsis inferens* Tns., a parasite of sugarcane shoot borer, *Chilo infuscatellus* Snell. *Entomon*, **5**, 191—200

RAO, G. N. & U. VIJAYALAKSHMI (1959) A note on the occurrence of certain parasitic fungi on insect pests of sugarcane. *Curr. Sci.*, **28**, 297

VARMA, ASHOK & MITRA, KRISHNA (1981) Recent researches leading to evolve a suitable control programme for stalk borer, *Chilo auricilius* Dudg. *Proc. Natn. Symp. Stalk borer*, Karnal, 63—65

CONTROL OF THE COREID BUG PEST ON COCONUT

A. VISALAKSHI, S. NASEEMA BEEVI, K. SASIDHARAN PILLAI, K. K. RAVINDRAN NAIR & N. MOHAN DAS

College of Agriculture, Kerala Agricultural University, Vellayani, India

(Received 12 May 1986)

A multilocational trial conducted in Trivandrum District (Kerala) for the control of *Paradasynus rostratus* Dist. (Coreidae: Hemiptera) damaging coconut, using carbaryl, HCH and endosulfan each at two dosages showed that sprays of carbaryl 0.1% and HCH 0.2% controlled the pest effectively.

(Key words: Coconut pest, *Paradasynus rostratus*, control)

The coreid bug *Paradasynus rostratus* Dist. has been noted as a pest of coconut in Kerala from 1972 (KURIEN *et. al.*, 1972, 1976). It has now become a serious menace to coconut cultivation in the southern districts of Kerala and is widely spreading to other areas as well. Results of a multilocational trial on the control of the pest conducted in Trivandrum District at Vellayani, Vazhamuttom and Chirayinkil, during 1982–1983, are presented in this contribution.

The pre-treatment counts of the nuts damaged by the bug were made of lower four bunches on selected trees and the bunches tagged. The trees for each treatment were selected at random. The treatments including control (sprayed with water only) were having ten replication each. The insecticides (see Table 1 for details) were sprayed with a rocker sprayer using 1.5 litre of spray fluid per tree. While spraying, the freshly emerging bunches in which fertilization had not been completed were excluded and a thorough coverage of the tender nuts,

TABLE 1. Percentage of damaged nuts on coconut trees treated with different insecticides in different locations.

Treatments* (Insecticides)	Mean per cent of damaged nuts			
	Chirayinkil	Vazhamuttom	Vellayani	Pooled
Carbaryl 0.2%	7.9	9.8	23.5	13.1
	(16.34)	(18.24)	(28.99)	(21.19)
Carbaryl 0.1%	21.9	15.6	31.2	22.6
	(27.87)	(23.25)	(33.95)	(28.36)
HCH 0.2%	14.8	22.0	22.9	19 8
	(22.64)	(27.97)	(28.55)	(26.39)
HCH 0.1%	29.3	35.8	33.9	33.0
	(32.75)	(36.73)	(35.59)	(35.03)
Endosulfan 0.1%	28.3	21.9	16.6	22.2
	(32.23)	(27.88)	(23.99)	(28.03)
Endosulfan 0.05%	40.7	36.3	38.4	38.5
	(39.62)	(37.08)	(38.29)	(38.33)
Control	52.2	58.7	67.6	59.5
	(46.17)	(49.99)	(55.31)	(50.49)
C D	8.26	12.58	13.22	7.23

* Significant at 5% level. Values in parantheses are angular values.

leaf axils and spathe was ensured. Six sprayings were given during the year skipping the heavy monsoon months. Observations on the nut-damage were made during the alternate harvests when the four tagged bunches were removed. The count of damaged nuts in the next four bunches was recorded and they were tagged for future indentification of the bunches on which damage was recorded. Thus the data of the nuts damaged on the different bunches were collected without any chance of repeated counting on any bunch.

The results presented in Table 1 indicate that all the insecticide treatments were significantly effective in controlling the pest at all the three locations. The pooled analysis of the data from the three locations indicated that carbaryl 0.2 and 0.1%, HCH 0.2% and endosulfan 0.1% gave significant control of the pest and hence could be recommended for the purpose.

Cost benefit ratio evaluations of the different insecticidal applications showed that HCH 0.2% ranked foremost followed by carbaryl 0.1%.

Acknowledgement: Thanks are due to Dr. N. MOHANA KUMARAN, Associate Director, NARP (SR) for tne facilities provided for the work and to Dr. P. SARASWATHY, Associate Professor of Statistics, for the analysis of the data.

REFERENCES

KURIAN, C., G. B., PILLAI, V. A. ABRAHAM & K. MATHEN (1972) Record of a coreid bug (nut crinkler) as a new pest of coconut in India. *Curr. Sci.*, **41**, 37.

KURIAN, C., V. A. ABRAHAM, & ABDULLA KOYA (1976) A new enemy of coconut in India. *Indian fmg.*, **27**, (5), 11—12.

Author Index

Reg. No. R. N. 29386/76

ENTOMON is covered in the following abstracting/indexing journals : *Chemical Abstracts* (Chemical Abstracts Service, The Ohio State University, Columbus, Ohio 43210, U. S. A.), *Review of Applied Entomology* (Commonwealth Institute of Entomology, 56 Queen's Gate, London SW9 5JR, England), *Science Citation Index* and *Current Contents Agriculture, Biology & Environmental Sciences* (Institute of Scientific Information, 3501 Market Street, Philadelphia, Pa. 19103, U.S.A.), *Biological Abstracts* (Biosciences Information Service, 2100 Arch street Philadelphia, Pa. 19103, U. S. A.), *Entomology Abstracts* and other relevant *Abstracts* (Information Retrieval Limited, 1 Falconberg Court, Lodon WIV 5FG, England), *Referativny Zhurnal* (The Institute of Scientific Information, Academy of Science of the U. S. S. R., Baltijskaya ul., 14, Moscow A—219, U. S. S. R.), *Current Advance in Biological Sciences*, 132 New Walk, Leicester LEI 7QQ, England.

Published by V. K. K. Prabhu and Printed at GEO Printers, Plamood, Trivandrum 695 004 for the Association for Advancement of Entomology.